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ERRATA.

P. 210, line 3. for "*Rock*" read "*Rocks*."—232, line 15 from bottom, *for* "true" *read* "more modern."—237, line 17 from bottom, *for* "forms" *read* "type."—238, 2d l. of note, *after* "No. 1" *insert* "and 2."—242, l. 24 from bottom, in part of edition, *for* "bed" *read* "sea."—242, l. 22 from bottom, in part of edition, *after* "were" *dele* "here."—243, l. 4 from top, *for* "so that" *read* "as, for example."—243, l. 23 from top, *for* "by thorough investigation" *read* "when thoroughly investigated."—243, l. 24 from top, *after* "reveal" *insert* "step by step."—244, l. 18 from bottom, *after* "course" *insert* "in close."—245, l. 7 from top, *for* "West" *read* "this region."—274, l. 14 from top, for "*photomorphosis*" read "*phytomorphosis*."—275, l. 11 from top, *for* "It" *read* "Grass."—275, l. 25 from top, *for* "flanes" *read* "flancs."—293, l. 11 from bottom, *for* "brocheure" *read* "brochure."—297, l. 16 from top, *for* "gellatinous" *read* "gelatinous."—302, l. 19 from top, *for* "plagairism" *read* "plagiarism," in some copies only.—305, l. 15 from bottom, *for* "brocheure" *read* "brochure."—308, l. 11 from top, *for* "verau-" *read* "Veran-", in some copies only.

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[SECOND SERIES.]

ART. I.—*On the Optical Phenomena presented by the "Silver-Spring," in Marion County, Florida;* by JOHN LECONTE, M.D., Prof. of Natural Philosophy in the South Carolina College.*

THE extraordinary reports in relation to the optical phenomena said to be exhibited by the "Silver Spring," induced me, under the invitation and guidance of my hospitable friend, Col. A. G. Summer of Florida, to visit it during the month of December, 1859. And although, as might have been anticipated, many reputed facts vanished under the scrutiny of careful observation, and all its so-called mysterious and wonderful phenomena are obviously referable to well-known physical principles; yet it may be interesting to give a brief statement of them, and to indicate how they may be referred to the recognized laws of physics.

This remarkable "Spring" is situated near the centre of Marion county, in the State of Florida, in latitude (about) 29° 15′ North, and longitude 82° 20′ West. It is about five miles north-east of Ocala, the county seat, and nearly in the axis of the Peninsula, being equally distant from the Atlantic and Gulf coasts. Its waters are discharged by a short stream bearing the same name (viz: "Silver-Spring") which, running about six miles, unites with the Ochlawaha (or Ocklawaha) a tributary of the St. Johns river. The stream takes its origin in a deep pool or head-basin, which is called, *par excellence*, the "Silver Spring." This

* Having been read before the "American Association for the Advancement of Science," at the Newport Meeting, August, 1860.

basin is nearly circular in shape, about 200 feet in diameter, and is surrounded by hills covered with live-oaks, magnolias, bays, and other gigantic evergreens. The amount of water discharged is so large, that small steamers and barges readily navigate the "Silver Spring" up to the pool or head-spring, where there is a landing for the shipment of cotton, sugar, and other produce. These steamers and barges make regular trips between the Silver Spring and Palatka on the St. Johns. The boatmen informed me that at its junction with the Ochlawaha, more than one half of the water is contributed by the Silver Spring stream. By means of a canoe, I explored the stream for about two miles from its head; its breadth varied from 45 to 100 feet, and its depth, in the shallowest parts, from 10 to 15 feet: the smallest depth measured was not less than 10 feet in the channel of the stream. The average velocity of the stream was rudely estimated at about two miles per hour: at the narrowest portions it was estimated at three miles per hour. According to the reports of the residents, the level of the water of the Spring at the landing is subject to comparatively slight fluctuations, scarcely ever exceeding two feet. These fluctuations of level seem to be connected with the season of rains. The commencement of the rainy season varies from the 15th of June to the 15th of July. The waters of the spring begin to rise about the middle of the season of summer rains, and attain their maximum height about its termination. The maximum depth of water in the pool or basin constituting the head of the silver spring, was found to be not more than 36 feet in the deepest crevice from which the water boils up: the general depth in the central and deep parts of the basin was found to be about 30 feet. These measurements were made by means of a heavy plumb-bob attached to a twine, to which bits of white cloth were secured at intervals of six feet, or one fathom. As the plumb-bob as well as each piece of white cloth indicating the fathoms, could be distinctly seen down to the very bottom, the measurements were of the most satisfactory character. Inasmuch as accurate quantitative determinations, however easily applied, are seldom resorted to by the unscientific, we need not be surprised, that the real depth of this spring falls very far short of its reputed depth. In South Carolina, the reported depth was variously stated at from 120 to 150 feet: on the confines of Florida it was reduced to 80 feet: while the smallest estimate in the vicinity of the spring was 45 feet! This affords an illustration of the general law, that the accuracy of popular statements bears an inverse proportion to the distance from the point of observation: probably, like all emanations from centres, following the law of inverse squares.

Doubtless, the greater portion of the water which flows in the Silver-Spring river is furnished by this principal or head-spring;

but there are several tributary springs of similar character along the course of the stream, which contribute more less to the volume of water. These usually occur in deep basins, or coves (as they are called), in recesses along the margin of the stream. The depth of one of these coves situated about 200 yards below the head-spring, was found to be 32 feet in the crevice in the limestone bottom from which the water boiled: in other deep parts of the basin, the depth was about 24 feet. The "Bone-yard," (so called from the fact that several specimens of the bones of the Mastodon have been taken from it,) situated two miles below the head-spring, is a cove or basin of a similar character. Its maximum depth was found to be 26 feet.

The most remarkable and interesting phenomenon presented by this spring, is the truly extraordinary transparency of the water; in this respect surpassing anything which can be imagined. All of the intrinsic beauties which invest it, as well as the wonderful optical properties which popular reports have ascribed to its waters, are directly or indirectly referable to their almost perfect diaphaniety. On a clear and calm day, after the sun has attained sufficient altitude, the view from the side of a small boat floating on the surface of the water near the centre of the head-spring, is beautiful beyond description, and well calculated to produce a powerful impression upon the imagination. Every feature and configuration of the bottom of this gigantic basin is as distinctly visible as if the water was removed, and the atmosphere substituted in its place!

A large portion of the bottom of this pool is covered with a luxuriant growth of species of water-grass, and gigantic moss-like plants (fresh-water Algæ), which attain a height of 3 or 4 feet. The latter are found in the deepest parts of the basin. Without doubt, the development of so vigorous a vegetation at such depths, is owing to the large amount of solar light which penetrates these waters. Some parts are devoid of vegetation: these are composed of limestone rock and sand, and present a white appearance. The water boils up from fissures in the limestones; these crevices being filled with sand and comminuted limestone, indicate the ascending currents of water by the local milk-like appearance produced by the agitation of their contents. At these points my plumb-bob was observed to bury itself in the mass of boiling sand.

My observations were made about noon, on the 17th and again on the 20th of December, 1859. The sunlight illuminated the sides and bottom of this remarkable pool as brilliantly as if nothing obstructed the light. The shadows of our little boat, of our over hanging heads and hats, of projecting crags and logs, of the surrounding forest, and of the vegetation at the bottom, were distinctly and sharply defined; while the constant waving

of the slender and delicate moss-like algæ, by means of the currents created by the boiling up of the water, and the swimming of numerous fish above this miniature subaqueous forest, imparted a living reality to the scene which can never be forgotten. And if we add to this picture, already sufficiently striking, that objects beneath the surface of the water, when viewed obliquely, were fringed with the prismatic hues, we shall cease to be surprised at the mysterious phenomena with which vivid imaginations have invested this enchanting spring, as well as at the inaccuracies which have been perpetuated in relation to the wonderful properties of its waters. On a bright day, the beholder seems to be looking down from some lofty airy point on a truly fairy scene in the immense basin beneath him, a scene whose beauty and magical effect is vastly enhanced by the chromatic tints with which it is invested.

Popular opinion has ascribed to these waters remarkable magnifying power. In confirmation of this, it is commonly reported that the "New York Herald" can be read at the bottom of the deepest parts of the pool. It is almost needless to state, that the waters do not possess this magnifying power, that it is only the large capitals, constituting the heading of this paper, which can be read at the bottom, and that the extraordinary transparency of the water is abundantly sufficient to account for all analogous facts. A variety of careful experiments were made with the view of testing this point, by securing printed cards to a brick which was attached to my fathoming-line, and observing at what depth the words could be read when viewed vertically. Of course, when looked at obliquely, the letters were distorted and colored by refraction. Numerous comparative experiments were likewise executed, in relation to the distances at which the same cards could be read in the air. The results of these experiments may be announced in a few words, namely:—That when the letters are of considerable size, say a quarter of an inch or more in length, on a clear and calm day, they could be read at about as great a vertical distance beneath the surface of the water as they could be in the atmosphere! Subsequently, my young friend, Dr. Henry M. Holmes, of "Silver Spring," at my suggestion, repeated several of these experiments, with identical results. In some instances, the cards were read by those who were ignorant of the words on them. The experiments were made on various sized letters, and at depths varying from 6 to 30 feet. The comparative experiments in reading the cards in air and water, serve to convey a more distinct idea of the wonderful diaphanous properties of the latter, than any verbal description.*

* Bouguer, in his *Traité d'Optique sur la graduation de la lumière*, (Paris, 1760.) gives the results of experiments made on sea water with his photometer, by which the loss of light in a column of $3^{m}\cdot11$ (=10·214 feet) of sea water confined in a

Some persons have thought that there was something mysterious in the fact, that objects beneath the surface of the water, when viewed obliquely, are fringed with prismatic hues. It is unnecessary to remind the physicist, that such a phenomenon is a direct physical consequence of the laws of dispersion of light by refraction. Observation proved that white objects on a dark ground were fringed with blue at the top and orange and red at the bottom; while the color of the fringing was reversed for dark objects on a white ground. This is exactly in accordance with recognized optical principles.* In the present case, the phenomenon is remarkably striking and conspicuous, probably, from two causes: *First*, because the extraordinary transparency of the water rendered subaqueous objects highly luminous; and *Secondly*, because the gigantic evergreens which fringed the pool cut off most of the surface reflection, which would otherwise have impaired the visual impression produced by the more feeble refracted and dispersed light proceeding from the objects. The shadow of the surrounding forest formed a dark background, analogous to the black cloud on which a rainbow is projected.

One of the optical phenomena presented by this spring, at first sight, seemed somewhat paradoxical:—namely, that when looking vertically, the depth of the pool appeared to be exaggerated. This fact was most strikingly and satisfactorily illustrated by the exaggeration of the apparent intervals between the bits of white cloth indicating the fathoms on my sounding-cord. The fathoms near the surface underwent a somewhat greater apparent elongation than those nearer the bottom, but all were exaggerated in length. This phenomenon was observed in all places and under all circumstances, was the same whether viewed with one or both eyes; and presented the same appearance to all observers. The apparent length of the upper fathom was variously estimated at from 8 to 10 feet.

In ordinary cases of considerable obliquity of view, it is a familiar fact, that the water appears to be shallower than it really is, in consequence of the seeming elevation of the bottom produced by refraction. Hence the foregoing facts in relation to the apparent exaggeration of depth, may seem to be inconsistent

prismatic box with plates of polished glass at the ends was in the ratio of 3 : 1 compared with the standard candle in air. As we had occasion to mention in vol. xxx, p. 243, this observer estimated that in sea water, at the depth of 311 French feet, the light of the sun would be equal only to that of the full moon, and at the depth of 679 feet would wholly disappear. Compared with these results the observation of Dr. LeConte on the transparency of Silver Spring appear remarkable, and we hope this excellent observer will take occasion to repeat Bouguer's measurements with the water of Silver Spring, and aided by the improved means of modern research in this department of physics.—Eds.

* Vide Herschel's Treatise on Light, *Encyc. Metrop.*, Article 429.

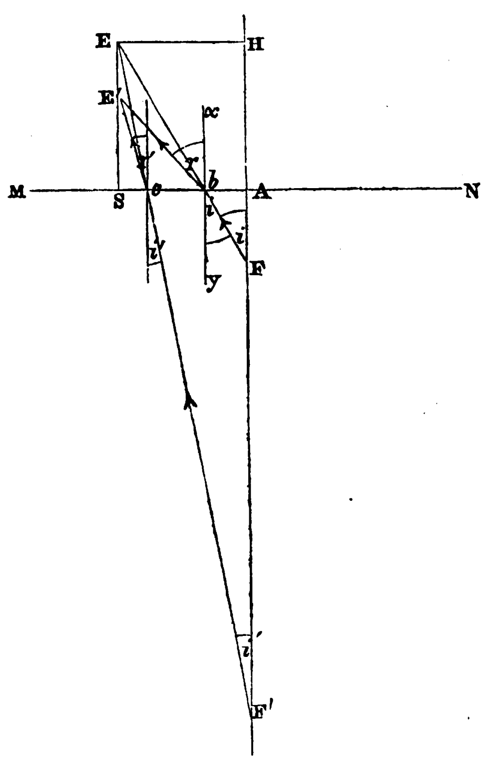
with recognized optical principles. But a little reflection will show that when the eye is placed near the surface of the pool, and when we are looking down in a direction approaching the vertical, the only method of estimating its depth is by means of the apparent intervals between intervening objects, as for example, the intervals between the branches of a sunken tree and the bottom, or between the fish and the subaqueous vegetation over which they are swimming, or between the fathom marks on the sounding-line. Now, from well known optical principles, it is obvious that the apparent distance between two objects thus viewed, depends, *caeteris paribus*, on the angle which they subtend at the eye. Thus, for instance, the apparent length of a fathom on the sounding-cord, will depend on the magnitude of the angle made by the rays of light proceeding from the upper and lower bits of cloth which mark the interval. And inasmuch as the rays of light proceeding from the fathom mark which is nearer the surface make a greater angle of incidence than those coming from the mark next below, they must undergo a greater degree of refraction, hence the apparent angle subtended at the eye by the interval in question (one fathom,) is greater than if it had been viewed in the air, and therefore the length seems to be exaggerated.

Moreover, as the apparent length of a fathom depends on the angle subtended at the eye, while the degree of refraction is proportional to the sine of the angle of incidence; it follows that when the incidence is large, the augmentation of the angle by refraction will be relatively greater than when it is small. Hence the uppermost fathom should appear to be longer than those below it; this is precisely in conformity with observation. Our estimate of the decrease of these apparent lengths with increasing depth, is doubtless vastly exaggerated by the greater fore-shortening of the lower fathoms. But as all of them seem to be more or less elongated, and as the whole depth is thus —as it were—measured by exaggerated linear units, it must appear to be greater than the reality.

The general result to which these optical laws lead is, that to an observer sitting in a boat in the middle of the pool, the bottom near the margin (if visible at all, for if the angle of incidence is too large, the light from subaqueous objects will be totally reflected, and will not emerge from the water,) will seem to be elevated and the water appear to be shallower than it really is; while the bottom near the centre will seem to be depressed, and the apparent depth exaggerated. In other words, near the margin, the depth is measured by the angle made at the eye by the rays proceeding from submerged objects with those coming from the shore-line; this angle being diminished by the refraction of the former, the depth is apparently diminished. On the

other hand, when looking directly downwards, we measure the depth by the angle made at the eye by rays emanating from upper and lower submerged objects, this angle being augmented by the greater refraction of the former, the depth is exaggerated. These physical principles thus afford a satisfactory explanation of the peculiar inverted bell-shaped appearance, which the basin presents to an observer floating near its centre. They likewise explain a fact which strikes the most casual observer: namely, that when the boat is advanced toward an apparently shallow spot situated at some distance, it appears to grow deeper as we approach the point in question.

The foregoing is a general physical explanation of the phenomenon of exaggeration of depth; but the principles of optics furnish us with the means of submitting it to a numerical test, and consequently, of showing its adequacy to account for all the facts observed. Following out the graphic method, the validity of the physical explanation was at first tested by construction. While this illustrated in a very satisfactory manner, the accuracy of the deductions which had been drawn, and their entire adequacy to explain all the observed phenomena, at the same time it enabled me to throw the question into a more severe mathematical form. Assuming the surface of the water to be a horizontal plane, and the sounding-line to be vertical, the application of a few elementary principles of geometry and trigonometry will enable us to submit the question to this more rigorous test. In the annexed figure, let M, A, N, be the surface of the water, H, A, F, F′, F″, etc., the sounding-line, E, the position of the eye receiving light from the successive fathom marks, F, F′, F″, etc., assuming no water to be interposed, and E′ the position of the eye receiving the corresponding rays after refraction by the water.



Let $ES=HA$ $=h$, (the height of E above the water).
" AF $=d$, (the depth of first fathom mark).
" $FF', F'F''$, etc., $=L$, (the length of the fathoms).
" i, i', i'', etc., $=$the angles of incidence.
" r, r', r'', etc., $=$the corresponding angles of refraction.
" n $=$the index of refraction for water$=1{\cdot}336$.

From the law of refraction, $\sin r=n\times\sin i$, and $\sin r'=n\times\sin i'$, etc. By geometry, the angle subtended at E by $FF'=i-i'$: also the angle at E′ after refraction $=r-r'$. Then by trigonometry we have $\cot i'=\dfrac{h+d+L}{(h+d)\times\tan i}$; $\cot i''=\dfrac{h+d+2L}{(h+d)\times\tan i}$. etc. Hence it follows, that when h, d, L, and i are given, i' i'' i''', etc., may be calculated, and consequently, r, r', r'', r''', etc., may be found: hence the angle subtended at E by FF' $(=i-i')$ as well as that subtended at E′ $(=r-r')$ by the same fathom-interval, become known. For the sake of illustrating this point, let us assume $h=2$ feet; $d=1$ foot; $L=6$ feet; and $i=30°$. Then, by the application of the formula above given, and the geometrical and physical principles already indicated, the following table has been calculated for the foregoing condition of things:

		Angle subtended at E.	Angle subtended at E′.	Ratio of E to E′.
i —30°	r —41° 54′ 46″	By $F\ F'$ —19° 6′ 24″	By $F\ F'$ —27° 17′ 18″	6 : 8·57
i' —10° 53′ 36″	r' —14° 37′ 28″	" $F'\ F''$ — 4° 18′ 24″	" $F'\ F''$ — 5° 48′ 34″	6 : 8·09
i'' — 6° 35′ 12″	r'' — 8° 48′ 54″	" $F''\ F'''$ — 1° 52′ 18″	" $F''\ F'''$ — 2° 30′ 37″	6 : 8·05
i''' — 4° 42′ 54″	r''' — 6° 18′ 17″	" $F'''\ F''''$ — 1° 2′ 41″	" $F'''F''''$ — 1° 23′ 56″	6 : 8·03

From this it follows, that, under the assumed conditions, the first fathom-interval is exaggerated in the ratio of 6 to 8·57, whilst the others are elongated in a ratio but slightly greater than 6 to 8. If the angle i (other conditions being the same) had been taken larger, the excess of elongation of the first fathom-interval would have been greater. It thus appears, that all of the fathom-intervals are exaggerated nearly in the ratio of 6 to 8 or 3 to 4:—that is, sensibly in the ratio of the sines of the angles of incidence and refraction for water. This is only true for small angles of incidence, that is, for the lower fathoms; for, in that case, the sines may be considered proportional to the angles. Hence, the real depth of this pool being 36 feet; the apparent depth, assumed to be measured by the exaggerated linear units would be 48 feet.

Strictly speaking, the rays of light emanating from the successive fathom marks, which, under the assumption of no refraction, reach a given point E, would not all after refraction, arrive at the same given point E′: so that, in strictness, the rays of light which enter the eye at E′ are, for the lower fathoms, those which emerge from the water under very slightly different angles of incidence from those given in the table. But it is ob-

vious, that its influence on the deduced ratio of the angles subtended at E and E′, would be wholly inappreciable.

The rigorous solution of this problem in physical optics, involves the application of that refined physico-mathematical reasoning, which has not ceased to exercise the ingenuity of some of the greatest geometers, since the period (in 1682), when Tschirnhausen first called attention to *Caustic Curves.* Sir John Herschel shows, that when the refracting surface is plane, and the refraction is made from a denser into a rarer medium, as from water into air, "the *Diacaustic* curve is the evolute of an ellipse, whose major axis is normal to the plane refracting surface; the radiant point being in the lower focus, while the centre of the ellipse is at the intersection of the major axis with the refracting surface."* In this case, the radiant is a fixed point, and the eye is supposed to view it under all possible angles of emergence. The case which we have under consideration is not materially different. Here the eye is fixed and the radiant consists of a series of equi-distant points descending vertically. In fact, Messrs. Engel and Schellbach, in their admirable *Darstellendende Optik,* have presented us with beautiful graphic representations of the exaggeration and distortion which submerged objects undergo when viewed by the eye placed in various positions above the plane refracting medium.†

Thus, it has been shown, that all of the beautiful optical phenomena presented by the Silver-Spring are referable to recognized physical principles, and that all of the so-called mysteries of its waters vanish under the scrutiny of exact science. It only remains to indicate the causes which produce the extraordinary transparency of the water, upon which, as has been shown, the entire group of phenomena is dependent. It may be remarked, that these diaphanous properties are perennial: they are not in the slightest degree impaired by season, by rain or drought. The comparatively slight fluctuations in the level of the water in the pool, to which allusion has been made, produced by the rainy season, are not, (according to the uniform testimony of the residents), accompanied by any turbidity of its waters. At first sight, it may seem paradoxical that, in a country where semi-tropical summer rains occur, the waters of this stream should not be rendered turbid by the surface drainage. But the whole mystery vanishes, when we consider the peculiar character of the drainage of this section of Florida. Although the surface of the

* *Vide,* Herschel's Treatise on Light. *Encyc. Metrop.* Article 238, Fig. 39.

† *Vide,* Darstellendende Optik, von F. Engel und K. Schellbach. *Halle,* 1856. Taf. 1, Fig. 3 et 4. Under such conditions, submerged objects not only appear to be exaggerated in length, but they seem to be more or less *curved* in the common plane of incidence and refraction, the centre of concavity being towards the observer.

country is quite undulating or rolling,—the summits of many of the hills being 30 or 40 feet above the adjacent depressions,—yet, there is no surface drainage: there is not a brook, rivulet, branch, or swamp to be found in this part of the State. The whole drainage is subterranean: even the water which falls near the banks of the Silver-Spring passes off by under-ground channels. There is not the slightest doubt, but that all of the rain-water which falls on a large hydrographic basin passes down by subterranean channels, and boils up and finds an outlet to the St. Johns river, by means of the Silver-Spring and the smaller tributary springs which occur in the coves along the margin of the stream. The whole surface of the country in the vicinity of Ocala,—and probably over the area of a circle of 15 miles radius whose centre is the Silver-Spring, is thickly dotted with lime-sinks; which are the points at which the surface water finds entrance to the subterranean passages. New sinks are constantly occurring at the present time. The beautiful miniature lakes, —whose crystal waters are so much admired,—which occur in this portion of Florida, are, doubtless, nothing more than extensive lime-sinks of more ancient date.

Under this aspect of the subject, it is obvious, that all the water which falls on this hydrographic basin boils up in the Silver-Spring, after having been strained, filtered and decolorized in its passage through beds of sand and tortuous under-ground channels. It thus comes out not only entirely free from all mechanically suspended materials, but completely destitute of every trace of organic coloring matter. According to the bargemen there is a striking contrast between the color and transparency of the waters of the Silver-Spring and Ochlawaha at their junction. The latter river drains a country whose drainage is not entirely subterranean. In addition to the abovementioned conditions, which persistently secure the waters of this Spring from the admixture of insoluble materials as well as from the discoloration of organic matters, it seems highly probable, that the minute quantity of lime which they hold in solution may exercise some influence in augmenting their transparency; for they appear to be more diaphanous than absolutely pure water. There is nothing *a priori* improbable in the idea, that the optical, as well as the other physical properties of the liquid, are altered by the materials held in solution. This is an interesting physico-chemical question which demands experimental investigation. It is proper to add that the waters of the Silver-Spring are not charged with more than the ordinary amount of carbonic acid, they deposit no carbonate of lime; so that, the amount of lime held in solution must be comparatively small.

Doubtless there are many other springs to be found in the State of Florida, whose waters possess the same optical properties as those of the Silver-Spring; although perhaps, their transparency may be less perfect. The "Suwanee Spring" is said to exhibit analogous phenomena; and the famous fountain situated ten miles from Tallahassee, called Wachulla or Wakulla, is represented as "an immense limestone basin, as yet unfathomed in the centre, with waters as transparent as crystal." Inasmuch as I have not examined these springs, I am unable to say how far the optical phenomena which they present, may be identical with those exhibited by that which is the subject of this paper.

As in some measure related to the peculiar system of subterranean drainage above indicated, it may not be deemed inappropriate to conclude this communication, with a few general remarks, in relation to the physical causes which have produced the several qualities of surface soil, which are found in the neighborhood of Ocala and the Silver-Spring. The whole of this portion of the Peninsula appears to have been originally composed of a mixture of sand and shell-limestone; probably of the Eocene period. The lime-rock comes to the surface, almost everywhere; in some cases, it is composed of nearly pure carbonate of lime; in others, silicification, to a greater or less extent, has taken place by the displacement of the lime by silex. But in all cases where its structure can be made out, it consists of a mass of conglomerated shells. The three grades of fertility at present existing in the soil of this portion of the State, appear to be owing to the greater or less facility with which the lime has been removed from it by aqueous agencies. In the fertile, and densely-wooded Hammock lands, large quantities of soft carbonate of lime may be found at or near the surface. In the Mulatto pine lands, which are extensively cultivated in cotton and Indian corn, the amount of surface carbonate is less abundant; a considerable portion of it having been either silicified or removed from the soil. While in the sterile sandy pine-lands, no lime is to be found: the whole of the rock having disappeared, excepting that which has undergone silicification. In the Hammocks, an impervious substratum of clay has prevented the lime from being carried off by the percolation of meteoric waters;—in the Mulatto lands (so-called because there is a subsoil of yellow clay) the substratum is less impervious, so that, a large portion of the lime has been removed;—while in the Pine barrens, in consequence of the absence of a clay subsoil, the whole of the surface lime has been carried off by subterranean drainage; leaving no surface rocks excepting those which are silicified. According to this view, the light pine lands, which now produce

cotton with so little labor, are in the transition stage to the pine barrens, and cannot be expected to retain their fertility for any great length of time, unless lime is restored to them by the cultivator. The heavily-timbered Hammocks require a greater outlay to bring them under cultivation; but they constitute the most valuable and enduring lands in this section of the State. Unfortunately they embrace but a comparatively limited area, when contrasted with the space occupied by the pine lands. The outlines of the Hammocks, as indicated by the dense growth of gigantic evergreens, is singularly and sharply defined, either dotting or intersecting the desolate pine-barrens; sometimes forming narrow sinuous verdant bands extending ten or fifteen miles, which, at a distance, remind one of extensive swamps, or the bottom lands bordering a stream.

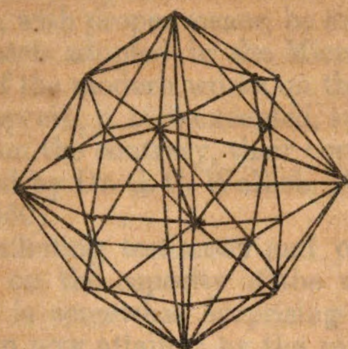
Columbia, S. C., June, 1860.

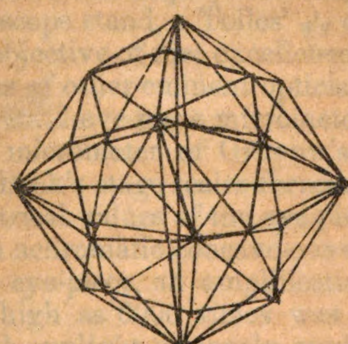
ART. II.—*On Nobert's Test Plate and the Striæ of Diatoms;* by W. S. SULLIVANT and T. G. WORMLEY.

THE limit of the resolvability of lines, or how small a space can exist between lines and still admit of their being separated under the microscope, appears to be an undecided point. Prof. Queckett (Treatise on the Microscope, 3d ed., p. 238, 1855) asserts that "no achromatic has yet been made capable of separating lines closer together than the $\frac{1}{75,000}$ of an inch." In the same work, p. 245, it is stated that Mr. Ross found it impossible to ascertain the position of a line nearer than the $\frac{1}{80,000}$ of an inch. We find also on p. 512 that Mr. De LaRue, in his extended examination of Nobert's Test Plates, was unable to resolve any lines closer than the $\frac{1}{81,000}$ of an inch. In Prof. Carpenter's work (The Microscope, 2d ed., p. 189, 1859) this sentence occurs: "the well defined lines on Nobert's Test Plates have not yet been resolved when they have approximated more closely than the $\frac{1}{85,000}$ of an inch."

From the foregoing it appears that actual experiment fixes the limit of resolvability at about $\frac{1}{81,000}$ of an inch: this does not, as is said, vary widely from the deductions of Fraunhofer and others, based on the physical properties of light. In this connection the remark (op. cit. p. 47) of Prof. Carpenter may be cited, "there is good reason to believe that the limit of perfection (in the objective) has now been nearly reached, since everything which seems theoretically possible has been actually accomplished."

On the other hand there are authorities who assert that lines much closer than the $\frac{1}{85,000}$ of an inch are resolvable. A few





years since Messrs. Harrison and Sollitt published (Microscopical Journal, vol. ii, p. 61, 1854) their measurements of the striæ of several diatoms, assigning to Amphipleura pellucida striæ as close as the $\frac{1}{120,000}$ to $\frac{1}{130,000}$ of an inch. These measurements have recently been repeated, and with exactly the same results, by Mr. Sollitt alone (Mic. Jour., viii, p. 51, 1859) who furthermore expresses the opinion that striæ as close as the $\frac{1}{175,000}$ of an inch can, with proper means, be seen. Mr. Sollitt's measurements have been adopted in the Micrographic Dictionary (1860) and most of the modern works on the Microscope, no one, Prof. Carpenter (op. cit., p. 188) excepted, suggesting a doubt as to their accuracy; on the contrary, their correctness seems to be expressly recognized by Dr. G. C. Wallich (Ann. & Mag. Nat. Hist. for February, 1860).

Such being the conflicting testimony and opinion of distinguished microscopists on the capacity of the modern objective for separating lines, it is somewhat surprising—in veiw of the high state of perfection now attained by the microscope, and of the number of its zealous devotees—that so few experiments have been made, bearing on this interesting point.

As a contribution toward that object, we propose to offer presently an analysis from actual measurements, as far as we were able to carry them, of one of those "marvels of Art," Nobert's Test Plates. In such investigations the quality of the instruments used being all important, we would state that the optical apparatus at our command was ample, consisting of a first-class Smith and Beck microscope stand, a Tolles' $\frac{1}{30}$ objective of 160° angular aperture—an objective of rare excellence in all respects—besides $\frac{1}{12}$ths and $\frac{1}{16}$ths of other eminent opticians, both English and American; also a solid eye-piece micrometer by Tolles, and an improved cobweb micrometer of Grunow's accurate workmanship. Smith and Beck's stage scales furnished the standards for fixing the micrometrical values of the eye-pieces. By means of Tolles' amplifier, an achromatic concavo-convex lens between the objective and the eye-piece, an amplification (by the standard of 10 inches) as high as 6000 times was obtained. This high amplification, with sunlight variously applied after passing through a small achromatic lens of long focus, was effective in resolution, and essential to the distinct counting under the micrometer of the lines of the test plate. The test plate used consisted of 30 bands of lines, each band varying but little from the $\frac{1}{2,000}$ of an inch in width, and having its lines a uniform distance apart. On one end of the plate is engraved by Nobert, in parts of the Paris line, the distance apart of the lines composing the first band, and thence on, the distance between the lines of every fifth band, as in the 2d and 5th columns of the following table.

Band.	Par. line.	Eng in.	Band.	Par. line.	Eng. in.
1	0·001000	$\frac{1}{11.248}$	20	0·000167	$\frac{1}{67{,}413}$
5	0·000550	$\frac{1}{20{,}471}$	25	0·000143	$\frac{1}{78{,}737}$
10	0·000275	$\frac{1}{40{,}943}$	30	0·000125	$\frac{1}{90.074}$
15	0·000200	$\frac{1}{56{,}297}$			

We add the 3d and 6th columns, giving the distances in parts of the English inch found by multiplying the decimals in the 2d and 5th columns by ·088815.

Analysis of Nobert's Test Plate of 30 *Bands.*

Bands.	Lines in each band.	Parts of an English inch.	Bands.	Lines in each band.	Parts of an English inch.
1	7	$\frac{1}{11{,}110}$	16	30	$\frac{1}{57{,}518}$
2	8	$\frac{1}{13{,}062}$	17	31	$\frac{1}{58.623}$
3	9	$\frac{1}{15{,}372}$	18	32	$\frac{1}{62.155}$
4	10	$\frac{1}{17{,}950}$	19	33	$\frac{1}{63{,}323}$
5	12	$\frac{1}{20{,}224}$	20	34	$\frac{1}{66{,}947}$
6	13	$\frac{1}{23{,}287}$	21	36	$\frac{1}{68{,}047}$
7	15	$\frac{1}{27{,}705}$	22	37	$\frac{1}{71{,}960}$
8	17	$\frac{1}{32{,}250}$	23	38	$\frac{1}{73{,}190}$
9	20	$\frac{1}{37{,}792}$	24	40	$\frac{1}{74{,}256}$
10	22	$\frac{1}{40{,}636}$	25	41	$\frac{1}{76{,}200}$
11	24	$\frac{1}{45{,}063}$	26	42	$\frac{1}{78{,}105}$
12	25	$\frac{1}{47{,}331}$	27	43	$\frac{1}{81.213}$
13	26	$\frac{1}{50{,}000}$	28	44?	$\frac{1}{83{,}917}$
14	28	$\frac{1}{52{,}610}$	29		$\frac{1}{86{,}334}$
15	29	$\frac{1}{55{,}900}$	30		

The figures in the 3d and 6th columns, showing the distance apart of the lines in each band, are the mean of numerous and slightly variant trials, particularly on the higher bands. Up to the 26th band there was no serious difficulty in resolving and ascertaining the position of the lines, but on this and the subsequent ones, spectral lines,* that is, lines each composed of two or more real lines, more or less prevailed, showing that the resolving power of the objective was approaching its limit. By a suitable arrangement, however, of the illumination, these spurious lines were separated into the ultimate ones on the whole of the 26th,

* The tendency of lines near the limit, either way, of the objective's resolving power, to run into each other and produce spectral or spurious lines, is readily shown by a low objective on the lower bands. Hence the mere exhibition of lines is not always conclusive evidence of their ultimate resolution. A practiced eye will generally distinguish the false from the true. Recourse to a higher objective often accomplishes the same; but when these fail, the micrometer only, together with a previous knowledge of the actual position of the true lines, can determine whether the lines exhibited are real or spurious. A $\frac{1}{12}$ or $\frac{1}{16}$ will show the 3 or 4 highest bands on this plate regularly and beautifully striped with lines much coarser than the true ones; the same with the $\frac{1}{30}$ on the last band.

and very nearly on the whole of the 27th band; but on the 28th, and still more on the 29th, they so prevailed, that at no one focal adjustment could more than a portion (a third or a fifth part) of the width of these bands be resolved into the true lines.

The true lines of the 30th band we were unable to see, at least with any degree of certainty, still, from indications, we have no doubt they are ruled as stated by Nobert.

It will be observed that our measurements of the lines on the 1st, 5th, 10th, 15th, 20th, bands vary somewhat from Nobert's registration on the plate as given in the first table above. Such discrepancies are to be expected, and by microscopists familiar with operations of this kind, are looked upon as unavoidable; but that on the 25th band is rather large to be accounted for in this way. We are unable to explain it, and can only say that our repeated measurements of it were very carefully made.

These experiments, together with those of others before noticed, induce us to believe that the limit of the resolvability of lines, in the present state of the objective, is well nigh established; but that this limit may be carried somewhat higher, we are not prepared to doubt, since the handsome advance lately achieved by Mr. Tolles in his $\frac{1}{80}$—combining wide aperture, fine definition, and high amplification—shows that the objective had not, as we were inclined to think, reached the stationary point.

The theoretical view of this question, that is, what may be the closest approximation of lines consistent with their separation under the microscope, we leave to those competent to the task, by whom, it is to be hoped, we may be favored with further information on this point.

With regard to the striation of Diatoms, an opinion generally prevails that the number of striæ on a given portion of a frustule, varies among individuals of the same species, within wide extremes. This opinion is probably traceable in part to one of the earlier publications on the subject, the paper of Messrs. Harrison and Sollitt before referred to, wherein (as in the more recent paper of Mr. Sollitt) measurements of several Diatoms are given showing great variableness in their striation. To these gentlemen much credit is due for their discovery of high markings, before unsuspected, on certain diatomaceous frustules; their measurements however and the alleged variableness of these markings we have not been able to verify, as will be seen by the following extract from our paper published (this Jour., March, 1859,) on this subject.

	Number of striæ in ·001″		
	H. and S.	Sm. Syn.	S. and W.
Navicula rhomboides	60 to 111	85	70
Pleurosigma fasciola	50 to 90	64	52 to 56
Pleurosigma strigosum	40 to 80	44	42
Nitzschia sigmoidea	105	85	70

Many frustules of these species, from different localities, have been measured by us and always with the same results. Pleurosigma fasciola has been specially designated by Mr. Sollitt, and also by Dr. Wallich, as very inconstant in its markings. Of this diatom we are fortunate in being supplied with abundant specimens, from various localities in England, particularly from the neighborhood of Hull. Several hundred valves, not a few under $\frac{1}{300}$ of an inch in length, were measured, and on no one were found striæ less than 52 or more than 56 in ·001″, much the larger number being 54. A similarly uniform striation has always been observed among the individuals of many other species examined by us.

To such uniformity of striation Amphipleura pellucida forms as yet no exception; this diatom is still a "res vexata" among microscopists; neither the striation nor the structure of its frustule is at all satisfactorily understood. The record of its striation is found to be thus:—in 1854 Messrs. Harrison and Sollitt's measurements made its striæ 120 to 130 in ·001″;—Prof. Carpenter (1856) first suggests the probability of some error in these measurements;—the writers of this paper declared themselves (this Jour., March, 1859) unable to "glimpse" the striæ;—Mr. Sollitt (Mic. Jour., Oct. 1859) measures them again and finds them still as low as 120 to 130 in ·001″, but gives it as the opinion of Mr. Lobb that "even those figures are too low and that they ought to be set down at 140 in ·001″;"—in the same number of the Microscopic Journal, Mr. Rylands sees "striæ, but much more distant than the 130 in ·001″ of the Hull microscopists;"—lastly Mr. Hendry states (Mic. Jour., July, 1860) that he has "come to a satisfactory conclusion, that it is a sad misrepresentation to set down the lines so high in the scale as 130 in ·001″, and that on a few shells lines may be counted at 42, and many at 60, 70 and 80 in ·001″." A perplexing record, truly!—reminding one of the celebrated Torbane Hill coal case (Mic. Jour., ii, p. 64).

It is our impression, notwithstanding these conflicting statements, that the diatom before us presented to all these gentlemen the same appearances, but their interpretation of these appearances have been widely different.

The testimony of our objectives, as we understand it, seems to indicate that this diatom has a minutely and irregularly broken up surface, which even on the *same valve*, can be made to show an apparent striation, varying from moderately coarse to extremely fine, according to the obliquity or intensity of the illumination, and to the grade, whether low or high, of the objective used, thus proving beyond question that the exhibition is illusory. In numerous trials, particularly on fine English specimens from Hull, sent us by Mr. G. Norman, we have entirely failed, with glasses too of unsurpassed excellence, to bring out,

regular, *distinct* and *unmistakable* striæ such as would be, at once, so recognized by an eye practiced on the striæ of other diatoms.

After all, it is not improbable, that true striæ yet unresolved, may exist on the valves of this species, and furthermore, that the apparent striæ of different observers may be similar to the spectral or spurious lines before noted as occurring on the bands of Nobert's Test Plate, when examined by an objective incapable of resolving them.

A summary of the foregoing may be briefly stated thus:—that our experiments lead us to believe

1st. That lines on Nobert's Test Plate, closer together than about the $\frac{1}{87,000}$ of an inch, cannot be separated by the modern objective.

2d. That no *true* striæ have yet been seen on the valves of Amphipleura pellucida.

3d. That the alleged variableness in the striation of diatoms among individuals of the *same* species has been greatly exaggerated: on the contrary, we find a remarkable uniformity, thus sustaining the opinion of Prof. Smith (Synop. Br. Diat., v. 2, Introd., p. 26) that for characterizing species "striation is the best guide."

Columbus, Ohio, Nov., 1860.

ART. III.—*On the Track of an Animal lately found in the Potsdam Formation;* by Sir W. E. LOGAN, F.R.S.*

(Read before the Natural History Society of Montreal, June, 1860.)

THE Potsdam sandstone is recognized in Canada and New York as the base of the Lower Silurian series. As far as we are certain of the formation in the province it rests unconformably upon the Laurentian series; but on the north shore of Lake Huron, the Huronian series supports unconformably a sandstone which has been supposed to be Potsdam; as no fossils, however, have been met with in it there, its equivalence is somewhat doubtful, particularly as the superior fossiliferous rock into which it passes, appears to be of the Bird's-eye and Black River group.

Mr. Barrande in a paper communicated to the Geological Society of France about a year ago, compares the Potsdam formation with the Primordial Zone, and appears disposed to unite it with the strata marked by *Paradoxides* near Boston in Massachusetts, and Placentia Bay in Newfoundland, the first locality yielding *Paradoxides Harlani* which he identifies with his *P. spinosus*, and the latter Mr. Salter's *P. Bennetii,* and probably other allied genera and species. But while no well ascertained Primordial spe-

* From the Canadian Naturalist, Aug. 1860.

cies have been met with in the Potsdam of Canada and New York, the formation appears in Canada to be rather allied to the strata above than those below it.*

In the Potsdam of Canada and New York, independent of fucoids, the number of species of which the forms have been either wholly or partially preserved is only three. Two of them are *Lingulæ*, named by Hall *L. prima*, and *L. antiqua;* and while these so far resemble one another that they might by some palæontologists be considered varieties of one species, we in Canada have a *Lingula* (*L. Belli* of Billings,) in the Chazy, which might almost be considered another variety of the same species, the peculiarity of them all being the length and sharpness of the beak. In Canada there is also found in the Potsdam, the impression of the spire of a large flat *Pleurotomaria*, which so strongly resembles the spire of *P. Laurentiana* (Billings) of the Calciferous, that they can scarcely be distinguished. In addition to these upward affinities in the only preserved form, there are beds of passage between the Potsdam and Calciferous formations, in which the strongly marked distinctive lithological characters of the two are well preserved, and at St. Timothy on the Beauharnois Canal those beds of the inter-stratification which are allied to the lower rock are occasionally marked by *Scolithus linearis* (Hall), supposed to be ancient worm-holes, by which the Potsdam is characterised in many parts.

Immediately beneath these beds of passage are the celebrated foot prints of Beauharnois, to which Professor Owen has given the name of *Protichnites.* Since these were described by Owen, nothing has been discovered to throw further light upon the forms of the animals which made these impressions; but in thinning a large specimen with some of the tracks on it, for the purpose of placing it in the museum of the Geological Survey, it was ascertained that the surface on which the traces were impressed must have been subject to the ebb and flow of a tide. The surface on which the tracks are impressed and the one immediately beneath, shew ripple-mark; the next in succession which is about an eighth of an inch below, shews wind-mark, in a number of sharp and straight parallel ridges from two to four inches long and an eighth or a quarter of an inch wide. These characterize a considerable surface, and are precisely similar to the marks so familiar to every person who has examined blown sand. The surface must thus have been alternately wet and dry, and the organic remains of the formation being marine, we have thus pretty clear evidence of a tide.

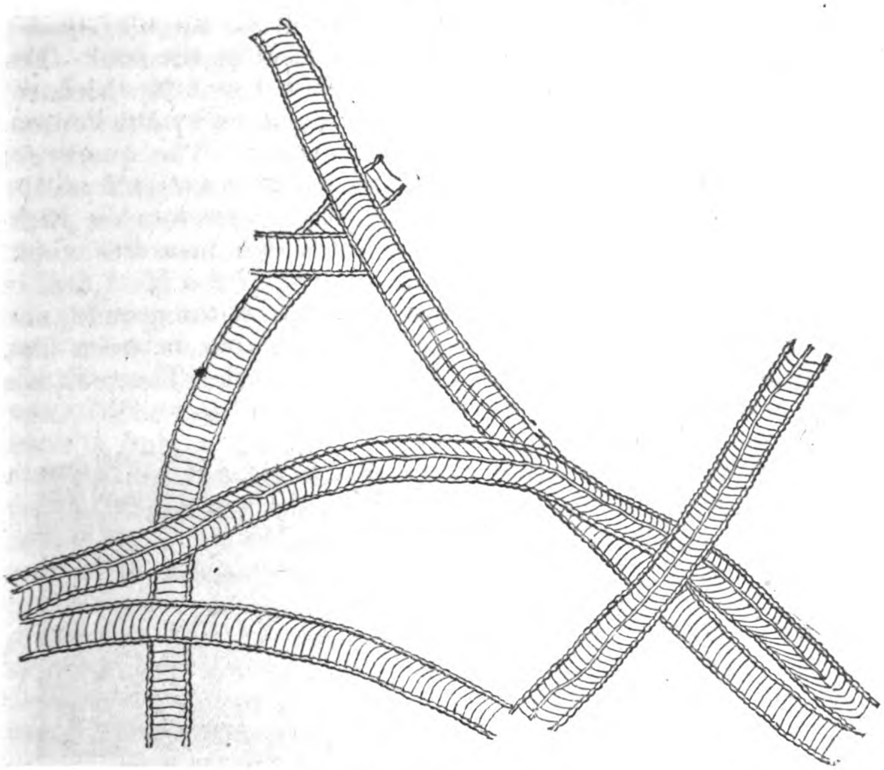
Proverbially unstable as water is, the mean level of the sea, that is the point which is half-way between high and low water,

* Since this paper was read two species of *Orthoceras* and an *Ophileta* have been discovered in Canada associated with *Lingula antiqua*, in the Potsdam Sandstone. The trilobite *Conocephalites minutus* (Bradley) has also been since described.

is supposed to be the least changeable level on the face of the globe, and taking it to be now pretty much as it was during the Lower Silurian period, we establish the means of knowing approximately how much the position where the tracks are found, is higher than it was when these were impressed, the limit of error being the number of feet which would represent the difference between the ebb and flow of the sea in the locality, or perhaps not more than fifty feet. We have thus a bench-mark to test the rise not only of these strata at Beauharnois, but of their equivalents, wherever else they may be met with.

Finding that this ancient sand bank was exposed at the ebb of tide we naturally look out for some coast to which it was related. The Potsdam sandstone terminates some twenty miles

1.



One-thirtieth natural size.

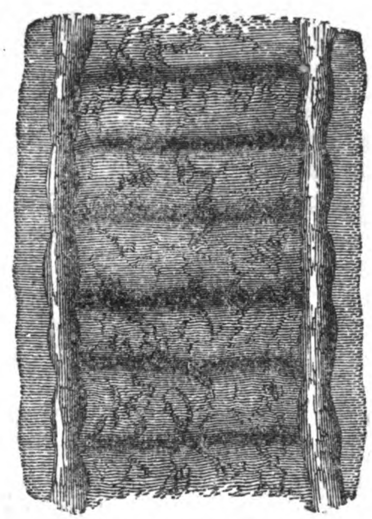
to the north at a very low angle against the foot of the Laurentide hills, which rapidly rise up 500 or 600 feet above the Silurian plain. There is little doubt that we have in the flank of those hills the ancient limit of the Lower Silurian sea, the shore of which is thus traceable from Labrador by the northwest, to the Arctic Ocean, a distance of 3,000 miles. But though we

have thus evidence of a Lower Silurian dry land and can scarcely suppose that it was wholly destitute of vegetation, we have not yet discovered any certain drifted vestige of its plants along many hundred miles of its coast.

The crustacean which impressed the tracks at Beauharnois must have been a littoral animal, tracks of which have now been found in several places nearer than Beauharnois to the marginal limit of the sea to which it belonged. These localities are St. Ann, Vaudreuil, Presqu'ile, Lachute, and St. Elizabeth, and they were last year observed in the neighborhood of Perth. In the last locality they are associated with a new and remarkable description of track, for the discovery of which we are indebted to my friend Dr. James Wilson of Perth, who sent me specimens of it in the month of November last.

The largest of the specimens was between two and three feet long by a foot wide, and the track upon it so singular that I became desirous of obtaining a greater extent of the trail. For this purpose, in the beginning of December, I sent Mr. Richardson to Perth, where he was guided to the quarry by Dr. Wilson, and shewn the bed in which the tracks occur. The quarry, of which the strata are nearly horizontal, is about a mile from the town, and with the aid of Mr. Glyn, the proprietor, Mr. Richardson obtained in fragments, a surface which measures about seventy-six square feet. To obtain this required a good deal of patience, for there was half a foot of snow on the ground, and from under this it was necessary to remove between two and three feet of rock in order to reach the bed. The rock is a fine grained white sandstone similar to that in which the *Protichnites* occurs at Beauharnois, and of that pure silicious character which is so well known to belong to the Potsdam formation wherever it is met with. The tracks are impressed on a bed which varies in thickness in different parts from one eighth of an inch to three inches. When the upper bed was removed, large portions of the track-bearing bed came away with it, and it was necessary to separate the layers. This was done by heating the surface with burning wood placed upon it, and then suddenly cooling it by the application of snow. This of course cracked and destroyed the thin bed with the impressed

2.

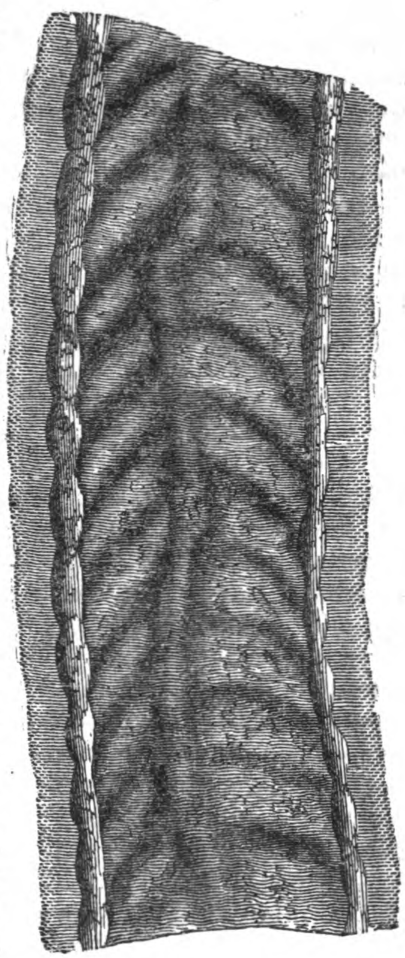


One-fifth nat. size.

tracks, but it left the mould of them on the underside of the upper bed, and by plaster casts from this we have obtained the true form of the original tracks.

These tracks consist of a number of parallel ridges and furrows something like ripple marks, which are arranged between two narrow continuous parallel ridges, giving to the whole impression a form very like that of a ladder, and as the whole form is usually gently sinuous it looks like a ladder of rope. The surface obtained shews six different trails, (fig. 1,) the longest of which is about thirteen feet, but they are all of the same breadth, and they may all have been impressed by one and the same animal. The breadth of the trails is about six inches and three-quarters to the outer sides of them.

3.



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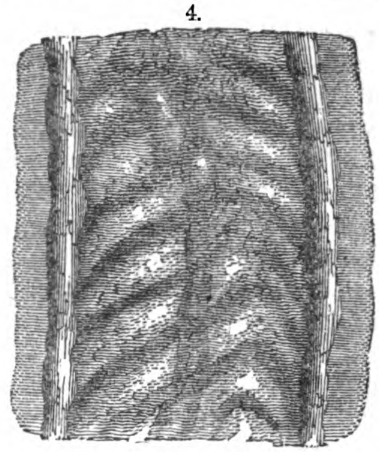
The transverse ridges and furrows are sometimes straight (fig. 2,) and sometimes curved (figs. 3, 4, 5.) When straight and regular they measure about an inch and three-quarters from the middle of one furrow to that of the next. The height of the ridge is usually from one and a half to two lines, and from the highest part of the distance to the middle of the furrows is about an inch and a quarter on one side and half an inch on the other, thus giving to the ridge a sharper slope on the shorter side. The tops of the ridges, and the bottoms of the furrows are somewhat rounded.

Though the transverse ridges are occasionally straight, (fig. 2,) they are in general either slightly or considerably curved (figs. 3, 4, 5,) and when so, the chord of the curve is seldom quite at right angles to the direction of the parallel side ridges, one end of the chord in the greatest obliquity observed being as much as two inches and a half in advance of the other (fig. 3). The height of the curve above the chord is sometimes as much as an inch and three

quarters. It is often somewhat pointed, and the highest part is not always in the middle between the parallel side ridges (fig. 4). The concave side of the curve is always on the steeper side of the tranverse ridges.

There runs along the track a ridge intermediate between the two parallel side ridges, (figs. 3, 4, 5), and though it is not so conspicuous as these, it is seldom altogether wanting, but appears to be, most obscure when the transverse ridges, or rounds of the ladder, are straight. This intermediate ridge does not keep parallel with the side ridges, but occasionally runs in sinuous sweeps from within an inch and a half of one side (fig. 5) to the same distance from the other; sometimes, however, it runs nearly parallel with the sides for a considerable distance, either in the middle or somewhat on either side of it. In one of the tracks there is in the course of the intermediate ridge a sudden dislocation of an inch and a quarter (fig. 3 towards the top,) on the opposite sides of one of the transverse ridges. The course of the intermediate ridge appears in general to coincide with the successive most salient parts of the transverse ridges when these are curved, but this is not always the case (fig. 4). The intermediate ridge appears most conspicuous where it crosses the transverse furrows, yet its crest or line of summit seems to undulate with the ridges and furrows, though not to so great a degree.

4.



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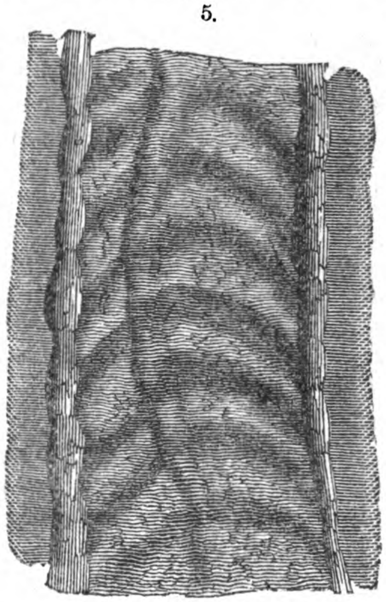
5.



One-fifth nat. size.

The inner flanks of the side ridges appear to be continuously even surfaces, making an angle of 155° with the plane of the intermediate spaces, and against these sloping flanks the surface of the transverse undulations form a decided, though very obtuse set of angles, just like waves rolling along an inclined plane in the direction of its strike. The side ridges

are rounded at the top, and while their exterior flanks are more precipitous than the interior ones, they swell out opposite to each transverse furrow, thus giving to the side ridges a beaded or knotted aspect, each bed of the series standing opposite a furrow. The highest part of these lumps is about three lines above the bottom of the furrows, and about a line and a half above the surface on which the track is impressed.

My naturalist friends to whom I have exhibited the specimens, appear disposed to consider the tracks those of some species of gigantic mollusc, and I am given to understand there is now living some small mollusc, whose track presents a series of transverse ridges and furrows, without, however, the longitudinal ones. From the resemblance of the track to a ladder, the name proposed for it is *Climactichnites Wilsoni*, the specific designation being given in compliment to its discoverer, Dr. Wilson.

ART. IV.—*Caricography;* by Prof. C. DEWEY.

(Continued from vol. xxix, p. 348, Second Series.)

No. 265. *Carex Emoryi*, Dew.

Spicis staminiferis ternis oblongis cylindraceis terminalibus, inferioribus brevioribus sessilibus approximatis et densifloris; pistilliferis quaternis longo-cylindraceis densifloris sessilibus foliaceo-bracteatis apice staminiferis, infima omnino fertili subremota; fructibus *distigmaticis* ellipticis basi teretibus brevi-rostratis ore integris squama ovata oblonga subacuta duplo longioribus.

Culm erect, scabrous above, triquetrous, with bracts long and leafy, surpassing, and scarcely sheathing it; the upper staminate spike clubform and short-pedunculate, the other two short, contiguous and sessile; the three upper pistillate spikes staminate at the apex, the lowest wholly fertile, nearly sessile and slightly sheathed; all cylindric, erect, about 1½ to 2 inches long and densely flowered; stigmas two; fruit narrow-elliptic, tapering below, flattish, obovate and apiculate or short-rostrate, with orifice entire, and scale ovate-oblong acutish and half the length of the fruit. Whole plant glaucous or pale green.

On the Upper Rio Grande; *Bigelow.* Named in honor of Major Wm. H. Emory, United States Commissioner on the United States and Mexican Boundary Survey.

This and all the species of this paper were described in the very important Botanical Report of Prof. Torrey, LL.D., in vol. ii, part i, pp. 229–232 of the Mexican Boundary Survey, published by Congress, 1859.

No. 266. *C. Barbaræ*, Dew.

Spicis staminiferis 2 (raro 3) cylindraceis erectis terminalibusque, suprema longa pedunculata, infima subelongata; pistilliferis 3 longis 2–4 uncialibus cylindraceis, superiore erecta brevibracteata apice staminifera, inferioribus longioribus subremotis subrecurvis basi laxifloris brevi-vaginatis foliaceo-bracteatis, omnibus nigro-purpureis; fructibus *distigmaticis* oblongo-obovatis apiculatis ore integris squama oblongo-obovata dorso pallida *mucronata* brevioribus; culmo erecto glauco longo-foliato et vaginato.

Culm erect, 16–20 inches high, long-leafy towards the root and long-bracted above, glaucous; spikes 3–6, cylindric, slender, blackish purple; staminate spikes 1–3, upper nearly two inches long and pedunculate, the lower sessile and both contiguous and shorter, the lowest longer than the last and more remote; pistillate 3, long cylindric, 2–4 inches long, and slender, the upper staminate at the apex and erect; the lowest longer, subremote and subrecurved, short-sheathed and loose-flowered at the base; stigmas two; fruit oblong-obovate, short rostrate, entire at the orifice, with the scale oblong-obovate, pale on the back, with the nerve extended into a *mucronate* point and sometimes making the scale emarginate.

Banks of streams at Santa Barbara, California; *Dr. Parry*. The locality gives name to the species.

No. 267. *C. Thurberi*, Dew.

Spica staminifera solitaria sublonga, terminali squamis oblongis obtusis mucronatis; pistilliferis ternis oblongo-cylindraceis subcrassis vix nutantibus densifloris, infima exserto-pedunculata sublonge vaginata; fructibus *tristigmaticis* ovato-oblongis multi-nervosis brevi-conico-rostratis subventricosis bidentatis squama brevi oblonga obtusa dorso trinervata scabro-aristata longioribus vel basi spicarum brevioribus.

Culm two feet high, erect, scabrous above and smooth below the spikes, towards the root leafy, leafy-bracteate; a single, erect and long staminate spike; pistillate spikes three, cylindric, thickish, dense-flowered, pedunculate, the lowest sheathed and exsert; stigmas three; fruit oblong or ovate-oblong, tapering into a shortish beak, many-nerved, two-toothed and inflated; pistillate scale short-oblong, obtuse, scabrous-cuspidate, and shorter than the fruit except at base of the spikes. Related to C. hystricina, Willd., but remote.

At Mabibi, Sonora, in June; *Thurber*. It bears the honored name of its discoverer, one of the exploring party.

No. 268. *C. Wrightii*, Dew.

Spicis staminiferis 2 (raro 3) oblongo-cylindraceis erectis bracteatis subremotis cum squama oblonga acuta vel inferne aristata;

pistilliferis 2–3 oblongo-cylindraceis, gracilibus remotis sublaxifloris exsertè pedunculatis, suprema apice stamenifera, infima longe vaginata exsertaque, omnibus foliaceo-bracteatis; fructibus *tristigmaticis* ovatis subconicis subtriquetris brevi-rostratis subscabris vix ventricosis bilabiatis squama ovato-oblonga cuspidata paulo longioribus vel basi paulo brevioribus.

Culm about a foot high, erect or subflaccid, leafy towards the root, and leafy bracteate; spikes 3–6, oblong cylindric; staminate 2, upper an inch long and pedunculate, the next one-third as long and near it usually, rarely a third which is remotish, and all bracteate; pistillate spikes, commonly 2–3, rarely one, rather remote and pedunculate, the upper staminate at the apex, the lowest longer pedunculate and exsert, all rather lax-flowered especially below; stigmas 3; fruit ovate, sub-conic, slightly triquetrous, short and round, short-rostrate, many nerved, bilabiate and subscabrous, a little longer than the ovate-oblong, rough-cuspidate scale, except at the very base of the spike: color of the plant, dark green.

In woods on the Colorado of Texas; *Wright.* It is honored by the name of its discoverer, another of the exploring party.

This species resembles C. scabrata Schw.; but it differs greatly in its staminate spikes, as well as in the pistillate and the fruit.

No. 269. *C. Schottii*, Dew.

Spicis staminiferis terminalibus 3–5 cylindraceis sæpe geminatis erectis approximatis nigro-rubris, superiori triunciali medio dilatata, reliquis brevioribus sessilibus contiguis vel infima remota et interdum geminata; pistilliferis 3 (raro 4) prolongo-cylindraceis gracillimis 6–8-uncialibus per-laxifloris inequaliter pedunculatis bracteatis, inferioribus longo-pedunculatis vix fructiferis vel abortivis cum squamis oblongis arctis obovatis vix acutis; fructu abortivo vel nimis immaturo *distigmatico;* culmis superne scabris, subprostratis? foliis bracteisque viridi-glaucis.

Culm near 20 inches high, triquetrous and scabrous above, subprostrate, with green glaucous leaves and bracts; spikes 6–8; sometimes staminate 5 and pistillate 3, or 4 and 3, 3 and 3, 3 and 4, most of which are long, and some very long, upper 3 staminate, near and almost geminate and quite variable, the highest 3 inches long and enlarged in the middle, with the dark red scale oblong and obovate, pale on the back; pistillate spikes 3, rarely 4, cylindric, very long, 4–8 inches and very slender, very lax-flowered and unequally pedunculate, the lowest long pedunculate and long vaginate, all leafy-bracteate and with scarcely the rudiment of fruit or else abortive; pistillate scale oblong, narrow-obovate, scarcely acute.

Banks of rivers, Santa Barbara, California; *Dr. Parry.* This species has some affinity to C. Darwinii, Boott, Trans. Lin. Soc., vol. xx, p. 120, but differs much. The prostration of the culms may have been caused by some crushing force, without which the pistillate spikes must have been long-retrocurved, as in C. pendula, Goodenough. It bears the name of another distinguished member of the exploring party.

No. 270. *C. monticola*, Dew.

Spica staminifera solitaria.inferne tereti erecta brevi-bracteata cum squamis oblongis obtusiusculis dorso excepto castaneis; pistilliferis binis sub-laxifloris, superiori sessili staminifera contigua, inferiore interdum subremota vaginata exserte pedunculata; fructibus di-tristigmaticis lato-ovatis oblongis convexo-concavis acutiusculis vix rostratis subvillosis nervosis ore integris vel subbifidis squama lato-ovata acuta longioribus vel inferiore mucronata paulo brevioribus; foliis vaginatis culmum superantibus.

Culm 8–10 inches high, scabrous above, leafy; leaves flat, rough on the edge, sheathed at the base and longer than the culm; one staminate ovate spike, with a sessile ovate pistillate spike near it and another pistillate spike subremote, often sheathed and exsertly pedunculate; stigmas *two and rarely three;* fruit ovate, flat, convex above, subacute scarcely rostrate, subvillose and nerved; lower scales of the fruit mucronate and a little longer than the fruit, while the others are acute and shorter than the fruit.

In the cases where the fruit is lenticular while the stigmas are sometimes three, probably one of the stigmas is barren or abortive.

Mountains east of San Diego, California; *Dr. Parry.* This is another of the few species having two stigmas with a single staminate spike.

Note 1.—*C. Umbellata*, Schk., Tab. w. w. w., fig. 171, and its var. *vicina* Dew., vol. x, [1], 31, and vol. xi, [1], 317, this Journ., have been found wide over the country.

The variety occurs also with *two* and *three* pistillate spikes, instead of one, near the staminate, besides the short and somewhat umbellate pistillate spikes near the root of the culm. Mexican Bound. Survey, vol. ii, Part I, p. 232.

Woods on the Colorado and Blanco rivers in Texas; *Wright.* Numerous specimens were brought by the discoverer, of the form given by Schkuhr, and of the variety mentioned; the latter being most common.

C. decidua, Boott, vol. xxvii, [2], p. 78, of this Journal, first found in Tierra del Fuego, afterwards in Sonora, California, by Dr. Parry, is presented fully in Boott, Illust. No. 157, Tab. 170. Dr. Boott shows its still wider range to the north in Oregon.

Note 2.—*C. phyllostachys*, p. 231, Mex. Bound. Surv., is a mistake for *C. Geyeri*, Boott.

ART. V.—*The motions of Fluids and Solids relative to the Earth's Surface;* by W. FERREL, Assistant in the Nautical Almanac Office.

1. UNDER the above title I have published a paper in the Mathematical Monthly, in which I endeavored, by a complete analytical investigation of the motions of fluids surrounding the earth, arising from the different circumstances of a difference of pressure caused by a difference of temperature, combined with the modifying forces arising from the earth's rotation, to give a satisfactory explanation of all the general motions of the atmosphere and the ocean, the cause of the greater barometric pressure of the atmosphere near the tropics than at the equator and the poles, and of the greater pressure generally in the northern hemisphere than in the southern, to account for the motions of revolving storms in both hemispheres, from the equator towards the poles in the parabolic paths, and to establish completely their gyratory character; none of which phenomena had ever been satisfactorily accounted for by any of the theories which do not take into account the effect of the earth's rotation. It has been suggested by several that a paper more popular in its character, although less complete, which should contain only the more essential parts of the analysis, and in which familiar illustrations should supply in some measure the more difficult parts of the analysis, would be more satisfactory to many readers. It is proposed, therefore, in this paper, in consequence of the general interest taken in the subject, to treat it acccording to this suggestion, and to give only the most essential part of the analysis, showing the influence of the earth's rotation, which being based upon well known principles, instead of being deduced from general fundamental equations, is very simple, but is sufficient for a general understanding of the subject.

I. *The effect of the earth's rotation upon moving bodies at its surface.*

2. If a body were set in motion upon the surface of the earth, supposed to be entirely without friction, it would not in general move in the circumference of a great circle around the earth, but would be continually deflected to one side by a force arising from the earth's rotation.

Let r be the radius of the earth,
θ the polar distance in arc,
φ the longitude, and
n the angular velocity of the earth's rotation.

Then $r \sin \theta$ is the distance of a body on the earth's surface from the axis of rotation, and $r \sin \theta n^2$ the centrifugal force in

the direction of a perpendicular to the earth's axis, arising from the earth's rotation. If in addition to the angular motion common to all bodies at rest on the surface of the earth, the body has an angular motion $D_t\varphi$ relative to the earth, then the centrifugal force becomes $r\sin\theta\,(n+D_t\varphi)^2$. Now if we resolve the preceding force in the directions of the meridian and a perpendicular to it, the part acting in the direction of the meridian, neglecting the small effect of the earth's ellipticity, is $r\sin\theta\cos\theta\,(n+D_t\varphi)^2$. The part of this force which gives ellipticity to the earth's surface, and which is necessary to keep a body at rest on the elliptical surface, and prevent it from sliding toward the pole, is $r\sin\theta\cos\theta\,n^2$. Hence the difference of these two forces, when the body has a motion eastward relative to the earth, is a deflecting force which has a tendency to cause the body to move from the pole toward the equator. The difference of these forces is $r\sin\theta\cos\theta\,(2n+D_t\varphi)\,D_t\varphi$, and hence when the body is entirely free to move in any direction, we have

$$(1.)\qquad r\,D_t^2\theta = r\sin\theta\cos\varphi\,(2n+D_t\varphi)\,D_t\varphi.$$

3. Again, if the body has a motion toward or from the pole, it must satisfy the well known principle of the preservation of areas, so that as it approaches the pole, and consequently the axis of rotation, the angular motion must be increased, that is, it must acquire a motion eastward relative to the earth, but if it recedes from the pole, it must acquire a relative westward motion. In order to satisfy the preceding principle, the motion must satisfy the following equation:

$$(2.)\qquad r^2\sin^2\theta\,(n+D_t\varphi) = \text{constant}.$$

Taking the derivative with regard to t we get

$$(3.)\qquad r\sin\theta\,D_t^2\varphi = -2r\cos.\theta\,(n+D_t\varphi)\,D_t\theta.$$

4. Equations (1) and (3) determine the motions of a free body on the earth's surface. If the body is constrained to move either in the direction of a meridian or a parallel of latitude only, the deflecting force instead of causing a deflection, causes only a pressure. If we put P for the part of the force or pressure acting in the direction of the meridian, which depends upon the earth's rotation only, and Q for the part depending upon the earth's rotation, which acts in the direction of a parallel of latitude, we have

$$(4.)\qquad \begin{cases} P = 2rn\sin\theta\cos\theta\,D_t\varphi \\ Q = -2rn\cos\theta\,D_t\varphi. \end{cases}$$

In the preceding equations $rD_t\theta$ represents the lineal velocity of the body in the direction of the meridian, and $r\sin\varphi D_t\varphi$ the lineal velocity relative to the earth in the direction of the parallel of latitude. Hence the deflecting force is the same in both directions in the same lineal velocity.

5. If v is the velocity of a body moving in any direction whatever, and F the deflecting force perpendicular to this direction, by resolving the preceding forces and velocities in the direction of v and the perpendicular to it on the right, we get

$$(5.) \qquad F = 2nv \cos\theta.$$

In the northern hemisphere $\cos\theta$ is positive, but in the southern negative. Hence, we have established this important principle, *in whatever direction a body moves, it is always deflected to the right in the northern hemisphere, and the contrary in the southern hemisphere.*

The forces resolved in the direction of v cancel each other, and hence the velocity is never accelerated or retarded.

6. Since rn^2 represents the centrifugal force at the equator arising from the earth's rotation, and is known to be $\frac{1}{289}$ of g or gravity, the preceding equation may be reduced to

$$(6.) \qquad F = \frac{2v\cos\theta}{289\,n}\,g.$$

This form of the equation is convenient for comparing the force F with gravity.

7. In the preceding equations rn is the lineal velocity of the equator, and is equal to 1523·2 feet, the second being the unit of time. Hence $n = {\cdot}000072924$. Also $g = 32{\cdot}2$ feet.

It may be remarked here that the preceding deflecting force is not an absolute force, such as would be required to deflect a moving body from a fixed direction in space, but is only relative, being somewhat of the nature of a centrifugal force, and arises from the fact that the direction relative to the earth to which the moving body is referred, is continually changing its direction with regard to fixed directions in space.

II. *The general Motions and Pressure of the Atmosphere.*

8. By the general motions of the atmosphere are meant all those motions produced by a difference of density between the equatorial and polar regions arising principally from a difference of temperature. If the atmosphere in all parts of the earth had the same density, every part would be in a state of statical equilibrium, and its surface and the strata of equal density would assume the elliptical figure of the earth's surface, and consequently the pressure of the atmosphere at the earth's surface would be everywhere the same. But the temperature of the atmosphere being less and consequently its density greater in the polar than the equatorial regions, the greater pressure of the polar regions causes the surface of the atmosphere and the strata of equal density in the equatorial regions to rise a little above the level of equilibrium, and hence the atmosphere in the upper regions flows toward the poles, while the greater pressure of the

polar regions causes a counter current toward the equator in the parts nearer the earth's surface, which would extend down to the earth's surface, if it were not for the modifying causes arising from the friction of the earth's surface, which will be explained. If the earth had no rotation on its axis, this interchanging motion between the equatorial and polar regions would be exactly in the directions of the meridians; but having a rotation, from what has been demonstrated in the preceding section, the atmosphere above in flowing toward the poles acquires an eastward motion relative to the earth's surface, and after descending in the polar regions and flowing back nearer the earth's surface toward the equator, it tends toward the west, and on arriving in the equatorial regions it has a westward motion. If it were not for the resistance of the earth's surface, the mutual actions of the strata upon one another, whatever the initial state of the atmosphere, would cause them to have finally the same east or west motion at all heights in the same latitude, and this motion would be such as to satisfy equation (2), and also, since the mutual actions of the strata upon one another could not affect the sum of the moments, it would be such that the sum of the moments of all the particles would be the same as that of the initial state arising from the earth's rotation and from any initial motion relative to the earth, which it might have had. This latter condition determines the constant in equation (2), which was shown in my paper in the Mathematical Monthly, to which I must refer for the method, to be, on the hypothesis of an initial state of rest relative to the earth, equal to $\frac{2}{3} r^2 n$. With this value of the constant the equation gives

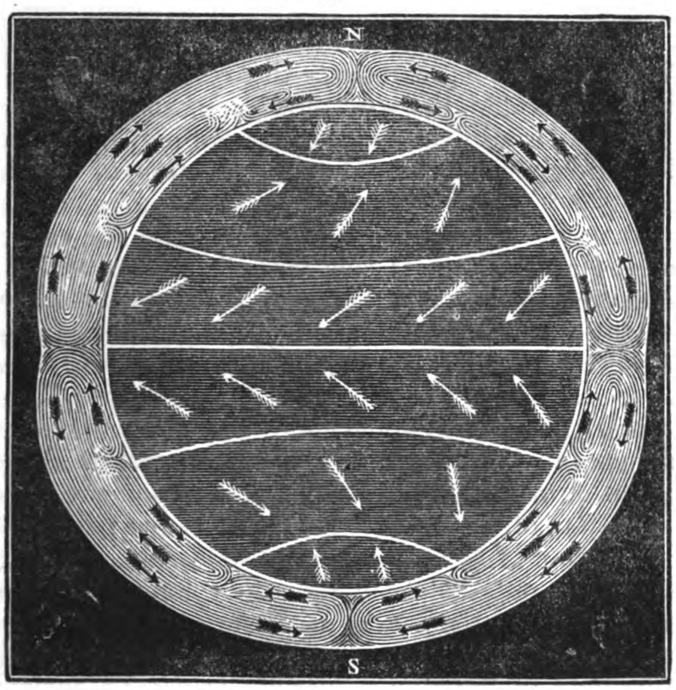
$$(7.) \qquad D_t\varphi = \left(\frac{2}{3\sin^2\theta} - 1\right)n.$$

9. Near the poles, where $\sin^2\theta$ is very small, $D_t\varphi$ and consequently the lineal velocity $r\sin\theta D_t\varphi$ must be very great. Toward the equator $D_t\varphi$ is negative, and hence the motion there is westward. Putting $D_t\varphi=0$, the equation gives $\sin^2\theta=\frac{2}{3}$, and hence the sine of the latitude where there is no motion east or west is equal to $\sqrt{\frac{1}{3}}$, which answers nearly to the parallel of 35°. Hence between this parallel and the poles the motion is eastward, but between it and the equator, toward the west. From what has been shown therefore in § 2, the eastward motion toward the poles, and the westward toward the equator, since $D_t\varphi$ is negative there, must both cause a pressure toward the parallels of 35°, and consequently an accumulation of atmosphere there, and a depression at the poles and at the equator. The amount of the pressure is represented by the term $r\sin\theta \cos\theta(2n+D_t\theta) D_t\varphi$, and hence toward the pole, where $D_t\varphi$ is very large, this pressure is very great, and at the poles it would

be infinite. Hence at the poles and at some distance from them, on the hypothesis of no resistances from the earth's surface, the atmosphere cannot exist. Between the parallels of 35° and the equator $D_t\varphi$ is less and also cos θ, and consequently the pressure from the equator and the depression there are comparatively small. It was shown in the Mathematical Monthly that in the case of a fluid surrounding the earth five miles high, the fluid would recede from the poles about 28° and be depressed at the equator about 4000 feet. This, however, is upon the hypothesis that the upward expansion of the atmosphere arising from a greater temperature is insensible.

10. The preceding results, it must be remembered, are all upon the hypothesis that the atmosphere is not resisted in its motions by the friction of the earth's surface. Although these results are much modified by the resistance of the earth's surface, yet they will be of great advantage in explaining its general motions; for as there can be no resistance until there is motion, the atmosphere must have a tendency to assume, in some measure, the same motions and figure as in the case of no resistances. Hence, towards the poles the general motions of the atmosphere must be towards the east, and in the torrid zone towards the west;

1.



but as these motions, in consequence of the resistances, are small in comparison with those in the case of no resistances, instead of the atmosphere's receding entirely from the poles, there must be

only a comparatively small depression there, as represented in the figure, and instead of its being about 4,000 feet lower at the equator than at the place of its maximum height near the tropics, there must be only a very slight depression there, both on account of the small pressure from the equator, and also on account of the upward expansion arising from a greater temperature.

11. That the atmosphere must assume the preceding figure in consequence of the eastward motion toward the poles and westward motion near the equator, will be readily understood from the following illustration. It is well known that if the atmosphere had the same motion of rotation with the earth, that it would assume the same figure. Now, if the whole atmosphere had a greater angular motion, that is, if it had an eastward motion relative to the earth, the increased centrifugal force would evidently cause it to accumulate at the equator and to be depressed at the poles. On the other hand, if it had a less angular motion, that is, a motion westward relative to the earth, it would accumulate at the poles and be depressed at the equator. Hence, since the motion is eastward in the higher latitudes and westward near the equator, it is plain that there must be a depression at both the poles and the equator, and consequently an accumulation having its maximum height at some parallel between.

12. The force which overcomes the resistance of the earth's surface to the east and the west motions of the atmosphere depends upon the term in equation (3) containing $D_t\,\theta$ as a factor, which depends upon the interchanging motion of the fluid between the equatorial and the polar regions, and hence the term must vanish at the equator and the poles. All the east or west motion of the atmosphere is consequently destroyed by the resistances at these places, and hence as $D_t\,\theta$ vanishes there also, there is a belt of calms at the equator, called the equatorial calm belt, and there must be also a region of calms about the poles.

13. As the motion of the atmosphere is east towards the poles and west near the equator, somewhere between the equator and the poles there must be a parallel of no motion east or west, which, in the case of no resistance, was determined upon the hypothesis of an initial state of rest, and found to be at the parallel of 35°, (§ 9). In the case of the atmosphere this parallel is entirely independent of the initial state of the atmosphere, and depends in a great measure upon the law of resistance, and hence it cannot be accurately determined. It is evident, however, that the east and west motions of the atmosphere at the earth's surface must be such that the sum of the resistances of each part of the earth's surface multiplied into its distance from the axis of rotation, must be equal to 0, else the velocity of the earth's rotation would

be continually accelerated or retarded, which cannot arise from any mutual action between the surface of the earth and the surrounding atmosphere. Now, as the part of the earth's surface where the motion of the atmosphere is west is much farther from the axis than the part where it is east, the latter part must comprise more than half of the earth's surface, unless the velocity of the eastern motion towards the poles is much greater than that of the western motion near the equator. Therefore, since one-half of the earth's surface is contained between the parallels of 30°, the parallels of no east or west motion at the earth's surface must fall within these parallels, and they are accordingly found on the ocean to be near the tropics. Hence the maximum height of the atmosphere, as represented in the figure, must also be near the same parallels.

14. The increase of pressure arising from the accumulation of atmosphere near the tropics, caused principally by the deflecting forces (§ 5) arising from the more rapid east and west motions of the atmosphere in the upper regions, where there is least resistance, gives the atmosphere a tendency to flow from beneath this accumulation both towards the equator and the poles, since the motions, and consequently the forces, which cause this accumulation, are much less near the surface. But on account of the greater density of the atmosphere towards the poles, it has a tendency also to flow, at the earth's surface, from the poles towards the equator. Between the parallels of greatest pressure and the equator, these tendencies combine, and produce a strong surface current, which, combining with the westward motion there, gives rise to the well-known northeast wind in the northern hemisphere, and the southeast wind in the southern hemisphere, called the trade winds. But between the parallels of greatest pressure and the poles, these tendencies are opposed to each other, and the one arising from the accumulation of atmosphere near the tropics being the greater in the middle latitudes, causes the atmosphere to flow at the earth's surface towards the poles; and this motion, combining with the general eastward motion of the atmosphere in those latitudes, gives rise to the southwest wind in the northern hemisphere and the northwest wind in the southern hemisphere, called the passage winds.

15. Near the poles, the tendency to flow towards the equator seems to be the greater, and causes a current there *from* the poles, which, being deflected westward (§ 5,) causes a slight northeast wind in the north frigid zone, and a southeast wind in the south frigid zone. But this is only near the earth's surface; and the general tendency of the atmosphere in the upper regions must be towards the east, as will be seen.

16. Since the atmosphere near the tropics can have no motion in any direction at the earth's surface, there are calm belts there,

called the tropical calm belts. Near the polar circles, where the polar and passage winds meet, there must also be calm belts, which may be called polar calm belts. The motions of the atmosphere, therefore, at the earth's surface, if they were not modified by the influence of continents, would be as represented in the interior of the figure, in which the heavy lines represent the calm belts. On account of the influence of the continents, these belts are somewhat displaced and irregular, and on account of the varying position of the Sun, they change their positions a little in different seasons of the year.

The southern limit of the polar winds in the northern hemisphere, and also the limit between the trade and passage winds, has been determined by Prof. J. H. Coffin, from the discussion of a great number of observations at different points, and given in a chart, in his treatise on the winds, published in the seventh volume of the Smithsonian Contributions.

17. That the atmosphere is depressed at the equator and the poles, and has its maximum height near the tropics, as has been represented, is indicated by barometrical pressure. It was formerly thought that this pressure, at the level of the ocean, was very nearly 30 inches in all latitudes; but it is now well established that it is much less towards the poles than near the tropics, and also a little less at the equator. Says Captain Wilkes: "The most remarkable phenomenon which our observations have shown is the irregular outline of the atmosphere surrounding the earth as indicated by the pressure upon the measured column at different parts of the surface. Our barometrical observations show a depression within the tropics, a bulging in the temperate zone, again undergoing a depression on advancing towards the arctic and antarctic circles."

Says Sir James Ross:* "Our barometrical experiments appear to prove that the atmospheric pressure is considerably less at the equator than near the tropics; and to the south of the tropic of Capricorn, where it is greatest, a gradual diminution occurs as the latitude is increased, as will be shown from the following Table, derived from hourly observations of the height of the column of mercury between the 20th of November, 1839, and the 31st of July, 1843."

Extract from Ross's Table.

Latitude.	Pressure.	Latitude.	Pressure.	Latitude.	Pressure.
	inches.		inches.		inches.
Equator,	29·974	42° 53′	29·950	55° 52′	29·360
13° 0′ S.	30·016	45 0	29·664	60 0	29·114
22 17	30·085	49 8	29·467	66 0	29·078
34 48	30·023	51 33	29·497	74 0	28·928
		54 26	29·347		

* Voyage to the Southern Seas, vol. ii, p. 383.

18. The following table, first published by M. Schouw, and reduced here from millimetres to English inches, shows that there is a similar bulging of the atmosphere in the middle latitudes and depression at the pole in the northern hemisphere, as has been observed in the southern hemisphere.

Place.	Latitude.	Pressure.	Place.	Latitude.	Pressure.
		inches.			inches.
Cape,	33° 0′ S.	30·040	London,	51° 30′	29·961
Rio Janeiro,	23 S.	30·073	Altona,	53 30	29·937
Christianburg,	5 30 N.	29·925	Dantzic,	54 30	29·925
La Guayra,	10	29·928	Konigsberg,	54 30	29·941
St. Thomas,	19	29·941	Apenrade,	55	29·905
Macao,	23	30·039	Edinburgh,	56	29·851
Teneriffe,	28	30·087	Christiana,	60	29·866
Madeira,	32 30	30·126	Bergen,	60	29·703
Tripoli,	33	30·213	Hardanger,	60	29·700
Palermo,	38	30·086	Reikiavig,	64	29·607
Naples,	41	30·012	Godthaab,	64	29·603
Florence,	43 30	29·996	Eyafiord,	66	29·669
Avignon,	44	30·000	Godhaven,	69	29·674
Bologna,	44 30	30·008	Upernavik,	73	29·732
Padua,	45	38·008	Mellville Isle,	74 30	29·807
Paris,	49	29·976	Spitzbergen,	75 30	29·795

19. From the preceding tables, it is seen that the barometric pressure is much less, especially in the southern hemisphere, towards the poles than at the equator, although the density towards the poles is much greater, and hence the depression there must be considerable.

20. It has been seen (§ 1), that, in consequence of the earth's rotation, the interchanging motion of the atmosphere between the equator and the poles give rise to a force, by which this motion itself is counteracted. For instance, the motion toward the poles in the upper regions causes an eastward motion which gives rise to a force toward the equator, and which, consequently, counteracts the motion toward the poles, and the motion toward the equator produces a westward motion which gives rise to a force acting in the direction of the poles, which counteracts the motion toward the equator. The motion of the atmosphere, therefore, between the equator and the poles, is not produced by the whole force arising from the difference of density between the equator and the poles, but by a small difference only between the two forces. Hence if the earth had no rotatory motion, the force which produces this motion would be very much greater, and there would be a sweeping hurricane from the pole to the equator.

21. It is evident, where the motions of the atmosphere are resisted by the earth's surface, that all the conditions cannot be satisfied by a motion at the surface from the poles towards the equator, and by a counter motion in the upper regions. For we have seen (§ 13,) that the atmosphere at the surface of the earth

must have an eastern motion in the middle latitudes; but it cannot have such a motion, unless it also have a motion toward the poles, in order that the deflecting force (§ 5) arising from this motion may overcome the resistance to the eastern motion. But it is evident there cannot be a complete reversal of the motions in the middle latitudes, but some portion of it must flow toward the poles in the upper regions, else the eastern motion there could not be greater than at the surface, which the conditions require. The motions, therefore, must be somewhat as represented in the figure. The part of the atmosphere next the earth's surface in the middle latitudes having a motion towards the poles, extends to a considerable height, since it generally embraces the region of fair weather clouds, as may be seen by observation.

22. Since the force arising from the eastward motion of the atmosphere above must resist in a great measure the tendency to flow from the equator to the poles, caused by the difference of level arising from a greater upward expansion of the atmosphere near the equator on account of a greater temperature, and since this difference of level, and consequently the tendency to flow toward the poles, must increase with the height, the eastward motion in the middle and higher latitudes must be much greater above than below, and in the trade wind region, near the tropical calm-belts, where the motion is westward below it must be toward the east above. This is also evident from the general consideration, that the whole amount of deflecting force eastward arising from the motion of the atmosphere towards the poles is equal to the deflecting force westward arising from its motion back towards the equator, and that the deflecting force eastward is principally above where there is less resistance than near the surface. Hence, at the top of Mauna Loa in the Sandwich Islands, and on the peak of Teneriffe, both of which places are near the tropical calm-belt at the surface, a strong southwest wind prevails. Hence, also, "on the eruption of St. Vincent, in 1812, ashes were deposited at Barbadoes, sixty or seventy miles eastward, and also on the decks of vessels one hundred miles still further east, whilst the trade wind at the surface was blowing in its usual direction." The eastward motion of the atmosphere above, in the latitudes of the trade winds, is also confirmed by observations made on the directions of the clouds at Colonia Tovar, Venezuela, latitude 10° 26′, as given in the Report of the Smithsonian Institution for 1857 (p. 254). While the motion of the lower clouds was in general from some point towards the east, the observed motion of nearly all the higher clouds was from some point towards the west.

23. From what precedes, the limit between the atmosphere which moves eastward in the middle latitudes and westward nearer the equator, which at the earth's surface is at the tropical

calm belt, must be a plane inclining toward the equator above. And since, according to (§ 21), the atmosphere near the earth's surface cannot have an eastward motion, unless it also has a motion toward the poles, this plane near the earth's surface must nearly coincide with the one which separates the atmosphere moving towards the poles from that moving towards the equator, in the trade wind regions, and hence the latter must also incline above towards the equator. This explains the winds at the peak of Teneriffe, which at the top always blow from the southwest while at the base they blow alternately from the northwest and northeast, changing with the seasons. As the tropical calm belt together with this dividing plane changes its position with the seasons, as will be explained, in the latter part of summer when this plane is farthest north, it still leaves the top of the peak north of it while the base is south of it; and hence the wind at the top always blows from the southwest, even when at the base it blows from the northeast. As this plane moves south in the fall, more of the peak gradually becomes north of it; and hence the southwest wind, which always prevails at the top, gradually descends lower on the sides of the peak until it reaches the base. Hence, when this plane reaches its most southern position, in the latter part of winter, the southwest wind prevails at both the base and the top.

24. The depression of the atmosphere at the poles and at the equator, and the accumulation near the tropics, may be explained in a general manner by means of the principle in (§ 5) that when a body moves in any direction in the northern hemisphere, it is deflected to the right, and the contrary in the southern. The atmosphere towards the poles having an eastward motion, the deflecting force arising from it causes a pressure towards the equator, and the motion near the equator being westward, the pressure is towards the poles; and hence there must be a depression at the poles and at the equator, and an accumulation near the tropics. Since this deflecting force is as $\cos\theta$, it is small near the equator; and, consequently the depression there is small.

25. According to the preceding tables of barometric pressure, there is more atmosphere in the northern than in the southern hemisphere. Says Sir James Ross, "the cause of the atmosphere being so very much less in the southern than in the northern hemisphere remains to be determined." This is very satisfactorily accounted for by the preceding principle; for as there is much more land, with high mountain ranges, in the northern hemisphere, than in the southern, the resistances are greater, and consequently the eastern motions, upon which the deflecting force depends, is much less; and the consequence is, that the more rapid motions of the southern hemisphere cause a greater

depression there, and a greater part of the atmosphere to be thrown into the northern hemisphere.

This also accounts for the mean position of the equatorial calm belt being, in general, a little north of the equator. But in the Pacific Ocean, where there is nearly as much water north of the equator as south, its position nearly coincides with the equator.

For the same reason the tropical calm belt of the northern hemisphere is farther from the equator than that of the southern hemisphere; and, on account of the irregular distribution of the land and water of the two hemispheres in different longitudes, it does not coincide with any parallel of latitude. In the longitude of Asia, where there is all land in the northern hemisphere and the Indian Ocean in the southern, this belt, which is also the dividing line which separates the winds which blow east from those which blow west, is farther from the equator than at any other place, as shown by Professor Coffin's chart.

26. In winter, the difference of temperature between the equator and the poles, upon which the disturbance of the atmosphere depends, is much greater than in summer; this causes the eastward motion of the atmosphere in either hemisphere during its winter to be greater, while in the other hemisphere it is less. Hence a portion of the volume of the atmosphere in winter is thrown into the other hemisphere; but, although the volume or height of the atmosphere is then less, yet, being more dense, the barometric pressure remains nearly the same. The difference at Paris, and in the middle latitudes generally, between winter and summer, is only about $\frac{1}{10}$ of an inch.

On account of this alternate change with the seasons of the velocity of the eastward motion of the atmosphere in the two hemispheres, the equatorial and tropical calm belts change their positions a little, moving north during our spring, and south in the fall.

III. *The Motions of the Atmosphere arising from local disturbances.*

27. Besides the general disturbance of equilibrium arising from a difference of specific gravity between the equator and the poles, which causes the general motions of the atmosphere, treated in the last section, there are also more local disturbances, arising from a greater rarefaction of the atmosphere over limited portions of the earth's surface, which give rise to the various irregularities in its motions, including cyclones or revolving storms, tornadoes, and water-spouts. When, on account of greater heat, or a greater amount of aqueous vapor, the atmosphere at any place becomes more rare than the surrounding portions, it ascends, and the surrounding heavier atmosphere flows in below, to supply its place, while a counter current is consequently pro-

duced above. As the lower strata of atmosphere generally contain a certain quantity of aqueous vapor, which is condensed after arising to a certain height, and forms clouds and rain, the caloric given out in the condensation, in accordance with Espy's theory, produces a still greater rarefaction, and doubtless adds very much to the disturbance of equilibrium, and to the motive power of storms. So long, then, as the ascending atmosphere over the area of greater rarefaction is supplied with aqueous vapor by the current flowing in from all sides below, the disturbance of equilibrium must continue, and consequently the local disturbances of the atmosphere to which it gives rise, whether those of an ordinary rain storm, or a cyclone, may continue many days, while the general motions of the atmosphere may carry this disturbed area several thousands of miles.

28. When the area of rarefaction is such as to cause the atmosphere to flow in below from all sides toward a centre and the reverse above, thus establishing a constantly interchanging motion between the internal and external part, the case becomes very similar to that of the general hemispherical motions of the atmosphere in which the motion is between the polar and equatorial parts. For if the earth's rotation on its axis is analyzed with reference to any other axis, the pole of which is at the distance of θ from the pole of the earth, it is found to have a rotation around this latter axis equal to $n \cos \theta$ (Peirce's *Analytical Mechanics*, § 25). Hence the interchanging motion between the internal and external part in this case must cause the internal part to gyrate around the centre from right to left in the northern hemisphere, and the external part the contrary way, and thus give rise to a cyclone or revolving storm just as in the case of the hemispherical motions the part nearest the pole acquires an eastward motion, and that near the equator a westward motion. This is also evident from the principle demonstrated in § 5, according to which the atmosphere in flowing toward the center below, must be always deflected in the northern hemisphere to the right, and consequently give it a gyratory motion around the center from right to left. In moving out above toward the external part, the deflection tends to give the atmosphere a gyratory motion the contrary way, and hence in flowing out above the gyratory motion which it has while rising to the upper strata in the interior, is not only destroyed but on arriving at the external part it has a gyratory motion the contrary way. In the southern hemisphere, since the deflections there are all to the left of the direction of motion, the gyrations are all reversed, which is the observed law of storms in all parts of the world, as shown by Redfield, and also by Reid, in his *Law of Storms.* It is also evident that at the equator, where $\cos \theta$ vanishes, upon which the deflecting force depends, there cannot be a cyclone, and hence,

of all those which Redfield has investigated, and given in his charts of their routes, none have been traced within 10° of the equator. The typhoons or cyclones, also, of the China sea, have never been observed within 9° of the equator.

29. In the case of the general hemispherical motions the internal or polar part is most dense, but in the case of cyclones the external part. Hence the motions between the centre and the external part are different, in the former case the motion toward the centre being above, but in the latter below. In the case of no resistances from the earth's surface this does not affect the gyrations, since on account of the action of the different strata upon one another, they all eventually have the same gyratory motion. But where there are resistances, they cause the gyrations in the external part to be most rapid above just as in the system of hemispherical motions, they are most rapid above in the internal or polar part.

30. If the gyrations were not resisted by the earth's surface it is evident that the rapid gyrations of the cyclone would cause the atmosphere to recede entirely from the centre, but on account of the resistance the very rapid gyrations are in general in a great measure prevented, so that instead of a complete vacuum the strata of the atmosphere are only somewhat depressed in the interior, as represented in fig. 2. For since the force which produces the gyrations depends upon the velocity of the flow to and from the centre, it is evident, that, at the centre and at the external part of the disturbed portion of atmosphere, where this velocity must vanish, the resistances destroy all gyratory motion. Hence, instead of very rapid gyrations near the centre, as in the case of no resistances, there must be a calm there, and the most rapid gyrations be at some distance from the centre, in accordance with observation. The diameter of the comparatively calm portion, in the centre of the large cyclones, is sometimes about 30 miles. The velocity of gyration of the external part, which, in the case of no resistances, is small, is in a great measure destroyed by the resistances of the surrounding atmosphere, so that it is, for the most part, insensible to observation, and only the more rapid gyrations of the internal part are observed. The motion of gyration combined with the motion at the earth's surface towards the centre, gives rise to a spiral motion towards the centre, exactly in accordance with the observed motions of the atmosphere in great storms or hurricanes, as has been shown by Redfield, in a number of papers on the subject, published in this Journal.

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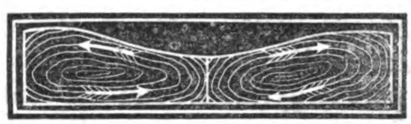

31. Since the atmosphere is depressed in the middle of cyclones, they must sensibly affect the barometer; and this is the true cause of all the great barometrical oscillations, as was first suggested by Redfield.* As the cyclone approaches, there is generally a very slight rise of the barometrical column, which is at its maximum at the greatest accumulation near the external part of the cyclone, after which it is gradually depressed, until the middle of the cyclone arrives, where the atmosphere is most depressed, when the barometer is at its minimum, and then it returns in a reverse manner to its former height, when the cyclone has passed. In great storms the mercury sometimes falls more than two inches. In oblong storms, and all imperfectly developed cyclones, the same phenomena must take place in some measure, as in a complete cyclone. We have reason to conclude, therefore, that nearly all the oscillations of the barometer are caused by a cyclonic motion of the atmosphere, by which it is depressed in the middle of the cyclones. The cyclones may be very irregular and imperfectly developed, and not of sufficient violence to produce a strong wind, and several may frequently interfere with one another, so that the oscillations may frequently be very slight ones only, and very irregular.

Since the gyratory motion of a cyclone, and the consequent depression at the centre, depend upon a term containing as a factor, cos θ, (§ 28), which is the sine of the latitude, according to the preceding theory of barometrical oscillation, the oscillations should be small near the equator, and increase towards the poles, somewhat as the sine of the latitude. Accordingly, at the equator, the mean monthly range of oscillation is only two millimetres, or less than $\frac{1}{10}$ of an inch, while there is a gradual increase with the latitude; so that at Paris it is $23 \cdot 66^{mm}$, and at Iceland, $35 \cdot 91^{mm}$. (Kaemtz's *Meteorology*, by C. Walker, page 297.)

32. The greater rarefaction of the atmosphere at some times than at others, without doubt, has considerable effect upon the barometer; but the theory which attributes the whole of the barometrical oscillations to the rarefaction of the atmosphere produced by the condensation of vapor in the formation of clouds and rain, can not be maintained; for according to that theory, in the rainy belt near the equator, where there are always copious rains during the day, which are succeeded by a clear atmosphere during the night, the oscillations of the barometer should be greatest, and towards the poles, where there is little condensation of vapor into rain, they should be the least; but we have seen that just the reverse of this is true. The atmosphere is extremely mobile, so that if there were much difference

* This Journal, [1], xx, 45.

of pressure between one part and the surrounding parts, the equilibrium would be at once restored if the motions toward the centre produced by this difference of pressure, did not give rise to a cyclonic motion, and thus to a centrifugal force combined with the deflecting force arising from the earth's rotation which in a great measure counteracts the force arising from a difference of pressure between the external and internal parts. If therefore the earth had no rotation, the oscillations of the barometer would be no greater in any part of the earth than they are at the equator.

33. When the disturbance of equilibrium is great, but extends over a small area only, the centripetal force is much greater than in the case of large cyclones, and the gyrations are then very rapid and very near the centre, as in the case of tornadoes. Tornadoes generally occur when the surface of the earth is very warm, and the atmosphere calm. For then the strata near the surface becomes very much rarefied, and are consequently in a kind of unstable equilibrium for a while, when from some slight cause, the rarefied atmosphere rushes up at some point through the strata above, and consequently flows in rapidly from all sides below, and then, unless the sum of all the initial moments of gyration around the centre is exactly equal 0, which can rarely ever be the case, it must run into rapid gyrations near the centre, and a tornado is the consequence. This may be exemplified by the flowing of water through a hole in the bottom of a vessel. If the fluid at the beginning is entirely at rest, it runs out without any gyrations; but if there is the least perceptible initial gyratory motion, it runs into very rapid gyrations near the centre.

34. In the case of tornadoes, which are always of small extent, the influence of the earth's rotation in producing gyrations is generally very small in comparison with that of the initial state of the atmosphere, so that the gyration depends principally upon the initial gyratory state of the atmosphere with regard to the centre of the tornado, and may be either from right to left, or the contrary. Hence there may be tornadoes at the equator, although there cannot be large cyclones. In large cyclones the effect of the initial state, except at the equator, is insignificant in comparison with the influence of the earth's rotation; and the latter, moreover, is a constant influence, while the former is soon destroyed by resistances. Hence large cyclones are of long duration, while small tornadoes, depending principally upon the initial gyratory state for their violence, are soon overcome by the resistances.

35. On account of the centrifugal force arising from the rapid gyrations near the centre of a tornado, it must frequently be nearly a vacuum. Hence, when a tornado passes over a build-

ing, the external pressure, in a great measure, is suddenly removed, when the atmosphere within, not being able to escape at once, exerts a pressure upon the interior of perhaps nearly fifteen pounds to the square inch, which causes the parts to be thrown in every direction to a great distance. For the same reason, also, the corks fly from empty bottles, and every thing with air confined within, explodes.

36. When a tornado happens at sea, it generally produces a water-spout. This is generally first formed above, in the form of a cloud, shaped like a funnel or inverted cone. As there is less resistance to the motions in the upper strata than near the earth's surface, the rapid gyratory motion commences there first, when the upper strata of the agitated portion of atmosphere have a tendency to assume somewhat the form of the strata in the case of no resistance. This draws down the strata of cold air above, which, coming in contact with the warm and moist atmosphere ascending in the middle of the tornado, condenses the vapor and forms the funnel-shaped cloud. As the gyratory motion becomes more violent, it gradually overcomes the resistances nearer the surface of the sea, and the vertex of the funnel-shaped cloud gradually descends lower, and the imperfect vacuum of the centre of the tornado reaches the sea, up which the water has a tendency to ascend to a certain height, and thence the rapidly ascending spiral motion of the atmosphere carries the spray upward, until it joins the cloud above, when the water spout is complete. The upper part of a water-spout is frequently formed in tornadoes on land.

When tornadoes happen on sandy plains, instead of water-spouts they produce the moving pillars of sand which are often seen on sandy deserts.

37. The routes of cyclones in all parts of the world, which have been traced throughout their whole extent, have been found by Redfield* to be somewhat of the form of a parabola, as represented in fig. 3. Commencing generally near the equator, the cyclone at first moves in a direction only a little north or south of west, according to the hemisphere, when its route is gradually recurvated towards the east, having its vertex in the latitude of the tropical calm belt. The motion of a cyclone toward the poles may be accounted for by the principle in § 5. The motion of the equatorial side of a cyclone in either hemisphere is always toward the east, and hence the deflecting force causes a pressure toward the equator, but that of the polar side being always toward the west, the deflecting force causes a pressure toward the pole. Now these deflecting forces being as the sine of the latitude, as may be seen from (§ 5), the pressure on the polar side toward

* See this Journal, Second Series, vol. i, Chart i.

the pole is greater than on the other side toward the equator, and hence the cyclone moves in the direction of the greatest pressure. It is not to be supposed, however, that there is an actual transfer of all the atmosphere of a cyclone from the equator to the polar regions. For the motions and pressure of the cyclone being greater on the polar side, where the deflecting forces which cause it are greatest, its action upon the atmosphere in advance of it is greater than on the equatorial side, where these forces are much

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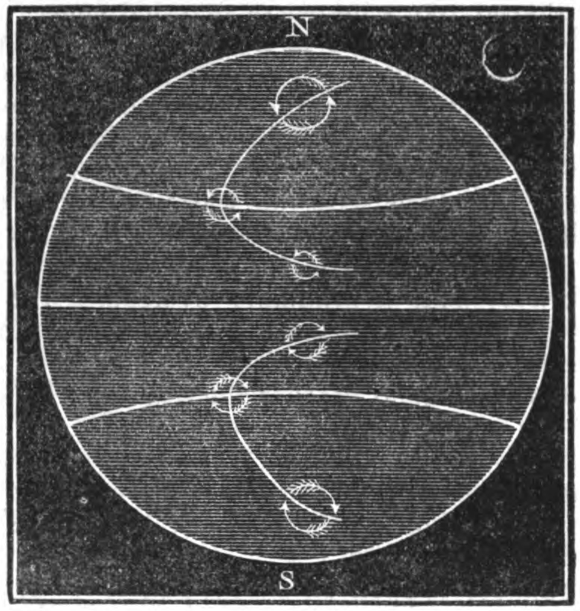

less, and hence new portions of the atmosphere are being continually brought into action on the one side, while the resistance of the earth's surface, and the adjacent portions of atmosphere on the other side, are continually overcoming the comparatively weak forces there, and destroying the gyratory motion of the cyclone; so that the centre of the cyclone is being continually formed in advanced portions of the atmosphere. Since many cyclones are more than one thousand miles in diameter, the difference in the violence of its action on the two sides is very considerable. Hence the interior and most violent portion of a cyclone, always gyrating from right to left in the northern hemisphere, and the contrary in the southern, must always gradually move towards the pole of the hemisphere in which it is. While between the equator and the tropical calm belt, it is carried westward by the general westward motion of the atmosphere there, but after passing the tropical calm belt, the general motion of the atmosphere carries it eastward, and hence the parabolic form of its route is the resultant of the general motions of the atmosphere, and of its gradual motion toward the pole.

IV. *The Motions of the Ocean.*

38. Besides the actions of the sun and moon which give rise to the tides, there are only two causes which can produce any sensible motions of the waters of the ocean. One of these is the action of the atmosphere upon the surface of the ocean, and the other, the difference of density between the water near the equator and that towards the poles, arising from a difference of temperature. The general motions of the atmosphere at the surface of the ocean have a tendency to cause a westward motion of the water in the torrid zone, and an eastward motion in the middle and higher latitudes; and from what we know of the effects of strong winds upon the ocean, we have reason to think that these general motions of the atmosphere are adequate to produce *sensible* motions, since, after the inertia of the water is once overcome, which, however small the force, is only a question of time, the only force necessary is that which is adequate to overcome the resistance of friction, which is very small where the velocity is small. The difference of density between the equator and the poles causes a slight interchanging motion of the water between them, and consequently, where not interrupted by continents, it produces a system of motions in the ocean similar to those of the atmosphere. Hence these two causes of oceanic disturbance, whatever their relative weight, both act in the same directions, and conjointly cause the observed westward motion of the ocean near the equator, and eastward motion towards the poles.

39. The westward motion of the water of the ocean in the torrid zone was first observed by Columbus, and is now well established; and observations also show that there is a motion towards the east in higher latitudes. A bottle thrown into the ocean near Cape Horn was picked up three and a half years afterward at port Phillip, Australia, a distance of 9000 miles, which makes the eastward velocity in that latitude more than 7 miles per day. And Sir James Ross, when sailing eastward near Prince Edward's Island, found himself every day from 12 to 16 miles by observation in advance of his reckoning. (*Voyage to the Antarctic Seas*, vol. ii, p. 96.) But a westward motion being established in the torrid zone, an eastward motion in the higher latitudes must be admitted; for, as was shown in the case of the atmosphere (§ 13), the one cannot exist without the other.

40. It has generally been supposed that the equatorial westward current of the ocean is caused principally by the action of the westward winds there; but Professor Guyot thinks that "it is too deep and rapid to admit of being explained by their action alone," and that "the difference of temperature betwen the regions near the equator and those near the poles controls all other causes by its power and the constancy of its action." (*Earth and*

Man, pp. 189, 190.) The torsive or deflecting force which causes the westward motion of the atmosphere and the ocean in the equatorial regions, and the eastward motion in the higher latitudes, has been shown to be as the velocity of the interchanging motion between the equatorial and the polar regions; and hence if this motion in both were similar, the relative amount of this force in each must be as the whole mass multiplied into the velocity of this motion between the equator and the poles. If we suppose the ocean to be 3 miles in depth, its mass is about 500 times that of the atmosphere, and hence if the motion between the equator and the poles were only $\frac{1}{500}$ of that of the atmosphere, the part of the force which gives it a westward motion near the equator, and an eastward motion towards the poles, arising from this cause, must be greater than that of the action of the atmosphere upon it, since the whole amount of this force in the atmosphere is not spent upon the ocean, but only that part which overcomes the resistances to its motions. Although the effect of temperature in producing a difference of density, and consequently of disturbing the equilibrium, is very much less in the ocean than in the atmosphere, yet since the amount of motion which a given disturbing force will produce where time is not considered, depends as has been stated, upon the amount of the resistances, and not upon the amount of inertia to be overcome; and since the resistances diminish as the square of the velocity, a very small amount of disturbing force arising from a difference of density must be adequate to cause an interchanging motion in the ocean between the equatorial and the polar regions equal to $\frac{1}{500}$ of that of the atmosphere; and hence we have reason to think that a greater part of the motions of the ocean is due to this cause than to the action of the atmosphere upon it.

41. The motions of the ocean being similar to those of the atmosphere, they must cause a slight elevation of the surface about the parallels of 30°, and a depression at the equator and the poles, just as in the case of the atmosphere, except that it will be less in the ratio of the relative velocities of the motions of the ocean and of the atmosphere. If we suppose the east and west motions of the ocean to be $\frac{1}{60}$ of those of the atmosphere at the earth's surface, which would require the maximum eastward velocity in the southern hemisphere to be about 10 miles per day, it would cause the surface of the ocean in the southern hemisphere to be about 15 feet higher at the parallel of 30° than at the pole, and also a little higher than at the equator. Now if the motions which cause this accumulation of water were the same at the bottom of the ocean as at the surface, there would be no tendency of the water to flow out at the bottom from beneath this accumulation; but since the motions there must be much less, it must flow out both towards the equator and the pole, especially

toward the latter, as the depression there is much the greater. Since the density of sea-water does not increase below the temperature of 28°, the density of the ocean does not increase beyond a certain latitude, and hence there is no flow of the water at the bottom from the poles toward the equator, arising from the maximum density at the pole, as seems to be the case in a very slight degree in the atmosphere, but the under current at the bottom, arising from the greater pressure about the parallel of 30°, must extend entirely to the poles; so that there must be a slight tendency of the water to rise at the poles, and flow at the surface some distance towards the middle latitudes. As the water toward the bottom of the ocean is always about the same as the mean temperature of the earth, when it first rises to the surface at the pole, it must be much warmer than it is after it has flowed some distance from it, and hence we have reason to think that there may be open polar seas, surrounded by barriers of ice at some distance from the pole, where there is the maximum temperature of the surface water. A surface current from the poles is indicated by the motions of icebergs in both hemispheres from the polar regions towards a lower latitude.

42. Where the east and west motions of the ocean are entirely intercepted by continents, as in the northern hemisphere, the water receives a slight gyratory motion from left to right. The westward motion of the waters of the Atlantic in the torrid zone, impinging against the continent of America, causes the surface of the water of the Caribbean Sea and the Gulf of Mexico to be a little above the general level, while the eastward motion of the northern part of the Atlantic causes the surface of the water adjacent to the eastern coast of North America, in that latitude, to be a little lower. Hence there is a flow of warm water from the Gulf of Mexico along the coast of the United States toward the lower level about Newfoundland, which, on account of the peculiar configuration of the coast about the Gulf of Mexico, and the peninsula of Florida, gives rise to the Gulf Stream. The eastward motion also of the northern part of the Atlantic causes the surface of the water on the western coast of Europe to be a little *higher* than the general level, while the westward motion in the torrid zone causes it to be depressed, on the western Coast of Africa, a little *below* this level, and hence the water of the eastern side of the Atlantic, flowing from a higher to a lower level, has a motion toward the the equator. The whole of the North Atlantic has therefore a very slight gyratory motion from left to right, and is supposed to make a complete gyration in about three years.

43. A portion of the equatorial current flowing from the higher level of the Caribbean Sea toward Cape Horn causes the Brazil current, which is deflected eastward by the general east-

ward motion of the Southern Ocean. The east side of the South Atlantic, as well as that of the North Atlantic, seems to have a motion toward the equator. Says Sir James Ross, "There is a current from the Cape of Good Hope along the west coast of Africa 60 miles wide, 200 fathoms deep, with a velocity of one mile per hour, of the mean temperature of the ocean." (*Voyage to the Southern Seas*, vol. ii, p. 35.) This cannot be a portion of the Mozambique current from the warm waters of the Indian Ocean, passing around the Cape of Good Hope, and giving rise to the equatorial current of the Atlantic, as has been supposed, but must come from the colder waters of the Southern Ocean. Hence the South Atlantic also has a tendency to assume a gyratory motion, and the equatorial current of the Atlantic is merely the equatorial portion of these two gyrations, with perhaps a small part of the Mozambique current passing around the Cape.

44. The general eastward motion of the water of the northern part of the Atlantic, and the consequent depression of the water next the coast of North America, is the cause of the cold current of water flowing from Baffin's Bay and the east coast of Greenland, between the Gulf Stream and the coast of the United States called the Greenland current. Since the warm water of the Gulf Stream, in flowing northward, is deflected toward the east (§ 5), and that of the Greenland current, in flowing south, tends toward the west, there is no intermingling of the waters of the two currents, but they are kept entirely separate as if divided by a wall, as has been established by the Coast Survey.

45. There must be a motion of the waters somewhat similar to the Gulf Stream and the Greenland current, wherever the great equatorial current impinges against a continent, and the eastward motion toward the poles is interrupted. Hence, on the eastern coast of South America there is the warm Brazil current which has been mentioned, and on the eastern coast of Asia there is the warm China current, flowing toward the north, similar to the Gulf Stream, and the cold Asiatic current insinuating itself between it and the coast, like the Greenland current. On the east coast of Africa, also, there is the Mozambique current flowing south like the Brazil current, and it is also now well established that, east of the Cape of Good Hope, the general tendency of the water is toward the south. This water must mingle with the general eastward current of the South Sea, and hence there is a slight tendency to a gyratory motion in the Indian Ocean also.

46. On the western sides of the continents there is a motion somewhat the reverse of this, and instead of a warm current flowing north, there is a cold one flowing toward the equator, as has been shown to be the case in the Atlantic. Hence, on the west coast of North America there is a flow of colder water

along the coast from the north, and on the west coast of South America is Humboldt's current, much colder than the rest of the ocean in the same latitude, both tending toward the equator to join the great westward current there across the Pacific, and to fill up, as it were, the vacuum which this current has a tendency to leave about the equator, on the west coast of America.

47. With regard to the gyratory motion of the oceans, it may be further added here, that such gyrations are clearly demonstrated by the positions of the isothermal lines, as has been shown by Professor Dana, in a paper read at the twelfth meeting of the American Association for the Advancement of Science (*Proceedings*, vol. xii, p. 77). According to this paper, the isothermal line of 68° F., in winter, extends, in the North Atlantic, from 56° N. on the American side, to 12° N. on the African, and in the South Atlantic, from latitude 31° S. on the South American coast, to 7° S. on the African side. Similar evidences are given of gyratory motions, in a less degree, in both the North and South Pacific, and also in the Indian Ocean.

48. When a portion of fluid on the earth's surface gyrates from left to right, the deflecting force arising from the earth's rotation being in this case toward the interior, the surface assumes a slightly convex form. The water of the North Atlantic having a very small gyratory velocity in comparison with that of the earth's rotation, the interior is a little elevated above the general level, and consequently the pressure upon the bottom increased. Now the gyrations which cause this elevation in the middle being principally toward the top, the increased pressure upon the bottom causes the fluid there to flow out on all sides with a very small velocity, towards the circumference, and hence the water at the surface has a slight tendency to flow in from all sides towards the interior to supply its place. This completely accounts for that vast accumulation of drift and sea-weed, covering a large portion of the interior of the North Atlantic, called the Sargasso Sea. From what has been stated, the North Pacific must also have a slight gyratory motion from left to right, and hence it likewise has its Sargasso Sea.

V. *The Motions of Solid Bodies at the Earth's Surface.*

49. It has been shown that if a body were set in motion upon the earth's surface it would move with uniform velocity, but would be continually deflected to one side. When the range of motion is small, $\cos\theta$ (equations (5)) may be regarded as constant, and hence the deflecting force in this case is constant, and must cause the body set in motion to describe the circumference of a circle. If we put ρ for the radius of curvature, and m for

the angular velocity about the center of curvature, the centrifugal force of the body is ϱm^2 which must be put equal to the deflecting force, (equation 5). Hence we have

$$\varrho m^2 = 2 n v \cos\theta$$

Also, since v is the lineal velocity of the moving body,

$$\varrho m = v.$$

From these two equations we get

$$\varrho = \frac{v}{2 n \cos\theta},$$

$$m = 2 n \cos\theta$$

50. When the range of motion is so small that $\cos\theta$ may be regarded as constant, ϱ and m are constant, and hence the body then moves with a uniform angular velocity in the circumference of a circle. If we put T for the time of a revolution, we shall have

$$T = \frac{2\pi}{m} = \frac{\pi}{n\cos\theta} = \tfrac{1}{2}\text{ day} \times \sec\theta.*$$

Hence, since v disappears in the result, T is independent of the initial velocity.

51. If a body is forced to move in a straight line F (equation (6)) is the lateral pressure of that body. If we put $v = 60$, which is a velocity of about 40 miles per hour, the equation gives $F = \frac{1}{5188} g$, at the parallel of 45°. Hence if a railroad train moves in a straight line 40 miles per hour at the parallel of 45°, the lateral pressure is $\frac{1}{5188}$ of its weight, and this is precisely the same in all directions, and not in the direction of the meridian only as has been generally supposed.

52. The deflecting force (§ 5) also causes the gyration of a vibrating pendulum. If the pendulum were suspended at the pole it would evidently vibrate in the same plane in space, and consequently perform a gyration in one day. Since the velocity of the earth's revolution around any other point of the earth's surface is $n\cos\theta$ (§ 28), the time of gyration there is $\frac{1\text{ day}}{\cos\theta} = 1\text{ day} \times \sec.\ \theta$.

53. This same deflecting force may be used to explain some of the motions of a rotating body. Suppose such a body be placed with its axis of rotation in any direction parallel with the horizon. Then the motions of the upper and lower parts being in contrary directions relative to the earth, and the deflecting force in both being either to the right or the left, according to the hemisphere in which it is, gives the axis of rotation a tendency to assume a perpendicular position. But there are other forces beside these horizontally deflecting forces, so that all the forces

* This result was erroneously given in the Mathematical Monthly, 1 day $\times$ sec. θ.

which tend to change the position of the axis would not be in equilibrium with the axis in that position. For the equatorial side then would have a motion coinciding in direction with the motion of the earth's rotation, while the other side would have a motion the contrary way, and consequently the centrifugal force arising from the motion of the earth's rotation, combined with that of the rotating body, would be greater on the equatorial than on the polar side, and give the axis of the rotating body a tendency to move in the plane of meridian. It might be easily shown, when the axis has a position parallel with the axis of the earth, that the forces which tend to change its direction are then in equilibrium, and consequently the axis, if free to turn in any direction, does not change its position.

54. These deductions from theory are in exact accordance with some very delicate experiments made by Foucault with a peculiar form of gyroscope, an account of which is given in this Journal, Second Series, vol. xv, p. 263. See also vol. xix, p. 141.

ART. VI.—*Geographical Notices;* by D. C. GILMAN. No. XV.

ARCTIC EXPLORATIONS.

1. *The Hayes Expedition.*—At a meeting of the council of the American Geographical Society, held November 15, 1860, Henry Grinnell, Esq., presented a letter from Dr. I. I. Hayes dated at Upernavik on the west coast of Greenland, Aug. 14, 1860, and reporting the progress up to that point of the Arctic Exploring Expedition under his command. It will be remembered that the particular object which Dr. Hayes has in view is to determine whether or not there is an Open Polar Sea, as Dr. Kane had good reason to believe. The opinions of Dr. Hayes on this subject are set forth in an article from his pen in this Journal, [2] xxix, 401, and more fully in a small volume entitled "An Arctic Boat Journey," (New York, 1859, 12°, pp. 375).

Dr. Hayes sailed from Boston, July 10, 1860, in a small vessel of 140 tons named the "United States," fitted out by the liberality of gentlemen in New York, Boston, Washington, Philadelphia, and other parts of this country, under the auspices, though not under the official responsibility of the American Geographical Society of New York. Every thing had been propitious up to the time of his writing from Upernavik, and Commander and crew were in excellent spirits in view of their long prospective seclusion from the inhabited world. Dr. Hayes still adhered to his plan of wintering at Cape Frazer (lat. 79° 42′).

The following is his letter:—

Ex. S. United States, Harbor of Upernavik,
North Greenland, Aug. 14, 1860.

Gentlemen—I have the pleasure to report for the information of the patrons and friends of the expedition my arrival at this port.

We made a quick passage from Boston. The schooner proved herself to be a good sea boat, and behaved admirably during some very heavy weather. No serious accident occurred.

On the twenty-first day out we were off Godhaven, and on the 5th inst. we anchored in the harbor of Proven. That settlement or outpost in the Upernavik district is forty miles southward from Upernavik. We were there detained in restowing our cargo, so that we might put below, the deck-load of lumber intended for our winter housing, and otherwise better prepare the vessel for the ice encounters. We put to sea again at the earliest practicable moment, and entered this port on the evening of the 12th inst. We found here a Danish brig, belonging to the Royal Company. She will be ready for sea to-morrow, and I shall send my mail by the hands of Dr. Rudolph, the retiring Governor of Upernavik, who returns in her to Copenhagen, and who has politely offered to do me this favor.

Through the kindness and liberality of Mr. Hanson, the Governor of Upernavik, and of Dr. Rudolph, I have obtained at Proven and Upernavik all the dogs that I require, and such furs as are essential to my party. Mr. Hanson and Dr. Rudolph have generously placed at my disposal everything which their personal property or the public stores will afford, for the promotion of the interest of the Expedition.

I have also been fortunate in obtaining the services of an excellent interpreter, Mr. Peter Jonson. He has had much experience in the management of dogs, and is a good hunter. He resides at Tessinsak, sixty miles northward from Upernavik, at which place I shall halt to take on board his team of dogs, which will make, with those on hand, twenty-five.

It is my melancholy duty to report the death by apoplexy, of my carpenter, Gebsen Caruthers. He was found dead in his bunk last Sunday morning. His body was placed in the burial-ground adjoining the church at Upernavik; and I have directed a railing to be constructed around the grave, and a suitable inscription to be placed over it. The loss of Mr. Caruthers is deeply to be regretted. He formerly sailed under Capt. De Haven, in the first Grinnell expedition, and in addition to his experience among the ice and his skill as a workman, he was thoroughly devoted to the best interests of this expedition, and I had great hopes of his future usefulness.

It is impossible for me to predict anything with respect to the prospects before us.

The season has been backward, but the weather has been very mild during the past ten days, and the recent southerly gales have doubtless broken the ice. The wind now blows fresh from the northeast, and if there is much ice before us it will be driven to the southwest.

We shall leave here to-morrow, and attempt at once the Melville Bay passage, and shall hope to make Smith's Strait not later than the 1st of

Sept. If successful in this endeavor, we shall have abundant time to secure a convenient harbor on the coast of Grinnell's Land. You are already aware that I anticipate (from observations made by myself upon this coast in 1854) reaching Cape Frazer, lat. 79 degrees, 42 minutes, where I propose spending the winter. A degree lower, however, will place one within practicable reach of my proposed field of exploration. If the condition of the ice will permit, I will immediately—after a winter harbor has been selected—carry forward the boat which I intend using for next summer's labors, and some provisions, as far north as possible, and then leave them, secured against the bears, and return to the schooner after the winter has firmly set the ice. Early next spring, we shall push forward advance depots, and should we find either ice or water, we shall endeavor to accomplish with boats or sledges, or with both, the chief object of the voyage before the close of the summer. If this fortune awaits us, we shall then return home without unnecessary delay. I do not, however, anticipate this result, but I expect that we shall be detained two winters.

I shall endeavor by every means to avoid a third year's absence. We carry with us, however, food and fuel for that period, and in the event of our being so long detained I do not fear adverse results. With the fresh supplies we have on board I believe we can resist the scurvy.

I do not hesitate to express my belief that, although we are late, we are in season. Capt. Inglefield left this port on the 16th of August, 1852, and the important results which he achieved during the following month in Smith, Jones and Lancaster Sounds, are well known.

I am informed by Governor Hanson that the whaling fleet did not succeed in passing Melville Bay this year, but you are aware of the fact that after a certain period it would be useless for them to succeed ; August is the most open month of the year.

I shall however avoid every unnecessary risk of being caught by the winter in the middle of the ice. Should the prospects of success appear to be peculiarly discouraging, I shall return southward and winter at one of the Danish settlements.

My party are in excellent spirits, and earnest in the performance of their duties, and you may rest assured that no effort will be spared to accomplish the object of our undertaking in the shortest possible time. To favor this, we have every facility which experience has indicated.

Our camp equipments are of the most compact and portable description. The food prepared expressly for the expedition by the American Desicating Company in New York, consisting of soup, beef and potato, is excellent, and fully equals my expectations. Of this food we have three thousand pounds—equal to about thirty thousand pounds of the raw material. I have tried it during the passage, and consider the several articles united preferable to the ordinary pemmican. Pemmican of the finest quality may at any time be made of our beef by the addition of lard, of which we have an abundant supply. With good and sufficient food, with every essential for the promotion of health and comfort, with united and earnest companions, and with a vessel well suited for the service, I have, upon leaving this last outpost of christian settlement, every reason to feel greatly encouraged and to expect success.

Trusting our lives and fortunes to the keeping of Him who alone is omnipotent, we sever in a few hours our connection with the civilized world, and enter upon our work, looking hopefully to the future.

With the best wishes for the prosperity of you and yours, and with many sincere thanks for the liberality which you and your associates have displayed in our outfit and preparation, I beg you to believe me,

With great regard your obedient servant,

ISAAC I. HAYES.

To Henry Grinnell, Esq., of New York; Richard Baker, Jr., Esq., of Boston; Prof. A. D. Bache, of Washington; Wm. Parker Foulke, Esq., of Philadelphia, and others who contributed to the Expedition.

Almost simultaneously with the receipt of this letter, Dr. William Longshaw, Jr., of East Cambridge, who had left this country with Dr. Hayes as Surgeon to the Expedition, arrived in Boston, having been compelled to return on account of injury to his eye-sight which rendered him nearly "snow-blind." He brought intelligence from Dr. Hayes a few days later than the date of the above letter, and has also communicated to the newspapers of Boston, many interesting details respecting the early part of the voyage, which the limits of this Journal will not allow us to reprint. The expedition sailed from Upernavik, August 14th, for Tessinsak where it had arrived on the 23d of that month. It was here that Dr. Longshaw parted from the company. Dr. Hayes found a small village of Esquimaux at Tessinsak (the home of his interpreter,) some of whom were employed to make up into clothing the furs purchased at Upernavik.

2. *Hall's Search for the Relics of Franklin's Expedition.*—A short time previous to the departure of Dr. Hayes, Mr. C. F. Hall of Cincinnati, conceived the project of searching for further remains of the Franklin expedition. About the first of June, 1860, he set out from New London, in a whaling vessel named the "George Henry" belonging to Messrs. Williams & Haven of that port. A letter just received from him dated at Holsteinberg, Greenland, July 17th, was communicated to the American Geographical Society by Mr. Grinnell, at the meeting above referred to. In respect to the plans and outfit of Mr. Hall we are happy to publish the following information, communicated in a private letter from Henry R. Bond, Esq., of New London, in answer to enquiries which were addressed to him on the part of this Journal.

"New London, Nov. 20, 1860.

* * * Mr. C. F. Hall is a printer who has resided at Cincinnati. He has had no experience whatever as an Arctic explorer, but has always felt interested in northern voyages of discovery and has particularly turned his attention to the various expeditions sent out in search of Sir John Franklin. On the return of M'Clintock's Expedition, he conceived the idea of fitting a

small vessel and sailing for King Williams Land (where the various Franklin relics were discovered) with the hope of finding some of Franklin's men, still living among the Esquimaux of that region. Being unable to secure funds sufficient for this purpose, he changed his plans and after an interview with Capt. Buddington of this place who was about to sail north on a whaling voyage, he decided with the consent of the owners, to take passage on the "George Henry," (Capt. B.'s ship) and pass the coming winter at that vessel's winter quarters in Cumberland Inlet—there to accustom himself to the climate, and as far as possible, to acquaint himself with the Esquimaux language, and habits of living, which latter he intends to adopt. In the spring he proposes to start in a boat (which he had prepared, and took with him for that purpose) with half a dozen or more picked natives, and plenty of dogs, for King Williams Land. His boat is so arranged, that it can be placed on sledges, so that he can make his way along, by land or water, as required.

After leaving Cumberland Inlet, he will either follow up the east coast of Fox Channel (yet unexplored between 66° 30′ and 70°) to the Straits of the Hecla and Fury, and thence southward and coastwise, until he reaches King Williams Land;—or he will cross Fox Channel at about 66°, thence across Rae Isthmus, by sledges to Committee Bay, and so on by water to his destination. He does not expect to have any white companions, but hopes to be able so to *Equimaux-ise* himself as to be able to communicate personally with, and make himself at home among, such natives as he may meet. He intends to be absent two or three years, during which time he expects to examine carefully King Williams Land, and the main land south, about Great Fish river, for relics of Franklin's Expedition, as he thinks it was not thoroughly explored by Rae or M'Clintock; and he will make particular search among all the natives of that region, for such of Franklin's men as may be still living. Hall takes with him such scientific instruments as he may need, a quantity of provisions, articles of trade for the natives and a full supply of ammunition on which latter he will mainly depend for his subsistence. His expenses are paid by contributions from individuals in Cincinnati, Philadelphia and New York. Messrs. Williams & Haven give him his passage in their "George Henry" to the whaling ground and he expects to make his way back to that point and return home in some whaler when his mission is accomplished.

Hall is physically rather a fat, heavy man, but is full of enthusiasm, pluck and spirit. His enterprise is a very daring one; still if he finds himself able to endure the climate, and the Esquimaux mode of living, he may accomplish something. If he reaches King William's Land in good condition, his chances of discovering other relics seem good." * * *

From Mr. Hall's letter to Mr. Grinnell we present a few extracts.

Holsteinberg, July 17, 1860.

"Our voyage thus far has been attended with calms, fogs and head winds, thus prolonging it to 39 days. The usual time may be set down at from 25 to 30. We arrived here in Holsteinberg harbor on the morning of July 7. The Rescue, of your first expedition in search of Sir John Franklin, in 1850, arrived at midnight of July 11. The George Henry and Rescue parted company the third night out, during a heavy wind; but Holsteinberg being the rendezvous, each vessel made its course direct here.

My health is excellent—better than ever. I enjoy myself beyond measure.

In this connection, I must speak to you of the coöperation I receive from Capt. Buddington, who has the command of both the George Henry and Rescue. If I could have had the choice of 10,000 men, excellent navigators in the waters of the north, and withal good and true men, I could not have selected a better one than Capt. Sydney J. Buddington. The house of Messrs. Williams and Haven, whose generosity in behalf of my voyage to the north should ever be remembered, know well that their interests in the George Henry and Rescue are in the hands of one of the most careful seamen that comes here in the Arctic seas.

It gives me pleasure, also, to communicate respecting the attention and hospitality extended to me by Gov. Elberg of Holsteinberg.

He, in company with the European ladies of Holsteinberg, have spent several hours on board the George Henry, and in nothing do they seem more interested than in examining the records of the first and second Grinnell Expeditions of 1850–'51, and 1853–'54–'55, as written and illustrated by the lamented Kane. Happily, I had these volumes with me. The Governor was also interested in the work of Captain (now Sir) F. L. McClintock. At a tea-party given by the Governor on the evening of July 10, I was invited to give a general statement of the accomplishments by McClintock, in his last voyage here to the Arctic regions. All were much amazed with the jovialness of Gov. Elberg, in reading before the whole company present McClintock's account of his gift of some coals to "the priest's wife, who was blue with cold." "The priest's wife," Mrs. Kier, was one of the party and seemed to enjoy the joke quite as well as any of us.

I must take the only copy of McClintock I have with me, as there are many statements in it that I wish to investigate personally, when on King William's Land next year.

I have visited various mountains of Greenland during our stay here, and know of no part of the world where there is better opportunity for the geologist to investigate the stratification of the earth's crust than here in the north. By the by, Gov. Elberg has presented me with numerous specimens of fossil fish, from North Strom Fiord, the only place where they can be obtained. Mr. McClintock says they are interesting as being of unknown geological date.*

Before me, on the table in my cabin, where I am writing this, is a beautiful bouquet of Arctic flowers, in great variety, sent me by several young Esquimaux ladies of Holsteinberg. I am astonished at the profuseness of Nature's productions here.

* See this Journ. [2], xxi. 313–338 and xxvi, 119, for age of Arctic rocks.—Eds.

July 18.—It is intended that we leave here at the earliest moment. Yesterday, by the assistance of Gov. Elberg and Capt. Buddington, I purchased an excellent team of sledge dogs. Next winter will find me half Esquimaux, I doubt not. Capt. Buddington intends finding good quarters for the George Henry, then proceeding with me through Frobisher's Straits and Fox Channel. Circumstances will decide as to penetrating also Repulse Bay. I shall learn much practical information this winter.

July 23, 1 *o'clock*, A. M.—A fresh breeze now prevails. We are now off for the west side of Davis's Straits."

P. S.—Since the foregoing was in type, a later letter has been received by Mr. Grinnell from Mr. Hall. It is written from his proposed winter quarters, lat. 62° 51′ 30″ N., long. 65° 04′ 45″ W., but the day and month are not specified. Hall had lost his expedition boat, but was in good spirits, hoping to prosecute his journey early in the spring. He claims to have discovered that Frobisher's Strait is not a strait but an inlet.

3. *Capt. Parker Snow's Proposal to Search for the Franklin Relics.*—A brief allusion has already been made in this Journal to the desire of Capt. Parker Snow of the British Mercantile Marine, to go in search of the records and other memorials which it is hoped may still be in existence, as relics of the lost Franklin expedition. At the Oxford meeting (1860) of the British Association he presented his views at some length, and his paper together with a report of the comments which it called out, an introduction and an appendix, has been recently published in a pamphlet form. (London, E. Stanford, 1860, 90 pp., 8vo.) Capt. Snow argues with much earnestness that all the information thus far gathered in respect to the fate of Franklin's party indicates that further traces of the expedition must still be in existence near King William's Land, and the peninsula of Boothia. He even thinks that survivors of the party may still be found. Holding these opinions, he desires to go on the search, and appeals to the British public for aid to the amount of £3500, which he thinks will be sufficient to equip a small vessel (say from seventy-five to ninety tons) and maintain a sufficient crew during a period of two years. He states his desire to enter the Arctic seas, through Behring's Straits, hoping to reach King William's Land the first summer.

A writer in the Tribune informs us that on account of inability to raise the funds which he hoped for, Capt. Snow now proposes a well-equipped boat-party, to leave England in the early spring, and reach King William's Land from the East, the sum already collected being sufficient to fit out such a party.

4. *McClintock's Arctic Soundings.*—The London Athenæum for November 17, 1860, contains the following letter from Capt. McClintock, giving some particulars in respect to his attempt to

make a line of deep sea soundings from Cape Farewell, the southern point of Greenland, to Ireland.

"Bulldog, near Rockall, Nov. 6.
"Closed at Killybeg's, Nov. 11.

"*My dear Collinson*,—We have nearly brought to a close about as *tough a job* as usually falls to the lot of the most hardworking—*even of surveying ships*. I have been up (in the ship) to the head of Hamilton Inlet, but South Greenland we found enveloped in an unusual amount of pack, so much so that I had to go up to Godthaab (64° north) before I could get into any harbor. On the 29th of September I succeded in getting into Julianshaab, where I expected to find the Fox, but could obtain no intelligence whatever respecting her. Our vessel was the *earliest* to arrive there this season; the ice having been impenetrable. The Fox (with Capt. Allan Young, Col. Shafner and Dr. Rae on board) had not arrived at Hamilton Inlet on the 17th of September, and I fear she has been detained by ice on the east coast of Greenland, although in a letter Young left for me at Reikiavik he says he intended going *first* to Julianshaab, to obtain an interpreter for the east coast. We have had desperate weather since the beginning of October. A gale on the 8th of October almost crippled us; we lost two boats, had our bowsprits snapped off by a sea, but as the gammoning held it fast, he has since been 'righted,' and at least *looks* shipshape. The iron tiller was also broken, and a vast deal of damage done to the sponsons, paddle-wheels, bulwarks, &c., lying to under bare poles for thirty hours, sleet aloft, and seas coming over us below, unable to cook, &c., disagreeable enough even for a '*Polar*.' To accomplish a line of soundings from Cape Farewell to Rockall, has proved rather beyond our powers at this late season, and with sueh continued severe weather; yet we have sounded at intervals the whole way, and I think sufficiently for ordinary purposes. Southwest of Iceland, where we expected 2,000 fathoms, we only found 748 fathoms, and in 1,260 fathoms we brought up a living star-fish! I tried in July, August, September and October, yet could not approach Cape Farewell from the southwest, within forty-five miles, the intermediate space being close pack; but at the same time the present is such a bad year that the Danes in Greenland say that they have not had one like it for nearly thirty years. It has been very favorable in Labrador, and very little ice is seen there. In Iceland also, the summer has been very fine. We have had much more icework than I expected, and the ship has suffered accordingly; paddle-arms bent, cutwater chafed away, and copper bolts standing out; the ship rolls very heavily, and is now quite *eager* for a good caulking. I think we have done our work well; at least we have done all we can. Instead of a deep channel leading into Hamilton Inlet, I doubt if forty-five fathoms can be carried inside the outer Islands, and would reduce the width of the main channel to about five miles, and there is an exterior bank along that part of the coast, having between 100 and 200 fathoms water on it. * * I have completed the soundings across to Rockall, but they are at long intervals, and not as straight in line as they would have been under more favourable circumstances of weather. I obtained deep water again inside of the Rockall Bank, 1,310 fathoms about mid-

way. * * The same southeast wind is still blowing which has scarcely ceased since the 18th of October.—Most sincerely yours,

"F. L. McClintock, R. N."

Heuglin's Search for Dr. Vogel, in Central Africa.—The fate of Dr. Edward Vogel, who set out in 1853, under the patronage of the British Government, to coöperate in the explorations of Central Africa then already undertaken by Richardson, Barth, and Overweg, has remained until the present time shrouded in complete mystery. This brave young man, the third son of Dr. Charles Vogel, a distinguished School Director in Leipsic, landed at Tripoli on the 7th of March, 1853, (his twenty-fourth birth-day) and began his African researches. On the first of January, 1856, he set out from Kuka, on the western shore of Lake Tsad intending to return to Europe by way of Wadai, Darfur, Kordofan and the Nile. The items of intelligence which have since been gathered from various sources give reason to believe that he reached the capital of Wadai, *Wara*, and that he was beheaded by the Sultan of that land, although indeed there is a possibility that he is still imprisoned in that country. Every effort to gain more definite information has hitherto failed.

By the kindness of Dr. A. Petermann, of Gotha, the editor of the Geographische Mittheilungen, we have been informed of a noble project, recently put forth, for enlisting the people of Germany in a special expedition, of which the object will be to determine if possible the fate of Dr. Vogel, to recover any remains which may be in existence of his journal and observations, and to prosecute those geographical and scientific inquiries to which his life has in all probability been an offering.

Fortunately the right man is known for this bold and difficult enterprise. Mr. Theodore von Heuglin, for seven years Austrian Consul at Chartum on the Nile, a traveller and observer whose writings are well known in geographical literature, stands ready to go forth in search of tidings of his countryman. A committee of which the Duke of Saxe-Coburg-Gotha is the President, Justus Perthes the Treasurer, and Dr. Petermann the Secretary, has recently been organized, and is diligently engaged in enlisting the sympathies and securing the aid of liberal Germans in promoting researches which the dictates of humanity as well as the interest of science so loudly call for.

From the various circulars which this committee have put forth, we gain the following additional particulars. Mr. von Heuglin is said to be qualified for his proposed task in all the most important requisites of an African explorer. He is accustomed to the climate, acquainted with the languages and habits of the natives, skilled in astronomical and geographical observations,—a good draughtsman, and by his previous residence and travels in Africa known to many influential persons.

Mr. von Heuglin proposed to leave Europe last autumn, and since in Cairo and Chartum he is acquainted with trustworthy servants and has a supply of scientific instruments, he will make the Nile lands the basis of his enterprise, endeavoring at the same time, to have reserved supplies at Bengasi, a town on the North African coast which has direct commercial relations with Wadai. He proposes, if pecuniary resources allow, to secure the services of a botanist as a companion. It is thought that three or four years will be occupied by the expedition, and that its entire cost, in addition to the private resources of the explorer, will fall between twelve and twenty thousand thalers. At the date of our last advices about one third of the necessary amount had already been secured, wholly from the German compatriots of Heuglin and Vogel. As the enterprise is regarded in "the fatherland" as an expression of national union in the advancement of science, we cannot but hope that among the adopted citizens of this country from Germany, so many of whom have acquired ample fortunes, there will some men of liberality be found ready and eager to aid in carrying forward a project which is full of promise.

MEDICAL STATISTICS OF THE U. S. ARMY.—The Surgeon General of the U. S. Army, Gen. Thomas Lawton, has recently presented to Congress a statistical report on the sickness and mortality of the United States Army, between Jan. 1855, and Jan. 1860, prepared by Dr. R. H. Coolidge, Assist. Surg. U. S. A. Although this document is chiefly devoted to sanitary discussions, it is of great value to the student of the physical characteristics of this continent, from the light which it throws on the geographical distribution of various forms of disease.

Two such reports have previously been printed, the first covering a period of twenty years, from 1819 to 1839, and the second a period of sixteen years, from 1839 to 1855. This may be considered accordingly as a supplement or continuation, the general arrangement before adopted being still adhered to, that is, the details being arranged in geographical divisions and regions having similar climatological features.

The volume is accompanied by an outline map of the United States, on a scale of 1 : 10,000,000, being unincumbered with the ordinary topographical details, and political divisions,—it presents to the eye in a very clear and satisfactory manner the limits of the seven military departments of this Government, the East, the West, Texas, New Mexico, Utah, Oregon and California, and also indicates the site of all military posts, both forts and arsenals throughout the entire country.

SQUIER'S COLLECTION OF ORIGINAL DOCUMENTS CONCERNING THE DISCOVERY OF AMERICA.—Mr. E. G. Squier, well known

for his archæological attainments and his printed works in reference to the early history of America, has announced the publication of a series of papers, chiefly from the Spanish archives, concerning the discovery and conquest of America, which he proposes to issue in the original, with translations, illustrative notes, maps and biographical sketches. The materials for the series have been collected, partly from the Spanish archives, and partly from Central America, during a period of ten years' study of American archæology. The scheme is deserving of the utmost encouragement, as under any circumstances it must appeal to a limited circle of students. The collection will be indispensable to the geographical or historical student, and an honorable companion and supplement to the great collections of Ternaux-Compans, Munoz and Navarrete. The proposal of Mr. Squier to print the original document as well as the translation in every case, will meet with universal acceptance. The first volume of the series, containing Palacio's description of Guazacapan, Izalco, Cuscatlan, Chiquimula, in 1576, has already appeared. Subscriptions for this and the subsequent volumes may be addressed to the Editor, Mr. E. G. Squier, 205 East Tenth Street, New York.

Among the manuscripts collected for publication are the following:

I. Carta dirijida al Rey de España por el Licenciado Don Diego Garcia, de Palacio, Oydor de la Real Audiencia de Guatemala, año 1576.

Report on the Provinces of Guazacapan, Izalco, Cuscatlan, and Chiquimula in the ancient Audiencia of Guatemala, with an account of the languages, customs, and religion of the aboriginal inhabitants, and a description, the first ever given, of the Ruins of Copan. *Original Spanish, Translation and Notes, with a Map.*—(Ready.)

II. Relacion del Descubrimiento y Conquista de las provincias de Nicaragua, dirijida al Rey de España, por el Capitan Gil Gonzalez Davila, desde la Ciudad de Santo Domingo de la Isla Española, 6 dias del mes de Marzo, de 1524 años.

Gil Gonzalez Davila was the first discoverer and conqueror of Nicaragua, and this is an account, under his own hand, of the circumstances of its reduction, and of the character of the country and its inhabitants. Although largely used by Oviedo, Peter Martyr, and Hererra, it has never been published.

III. Cartas del Adelantado Don Pedro de Alvarado, escrita al Rey de España y al Capitan Hernando Cortez, sobre la Conquista y Pacificacion de los Reynos de Guatemala, y la Expedicion que hizo desde el Puerto de Iztapa á Peru, etc.

These letters of Don Pedro de Alvarado, the celebrated Lieutenant of Cortez in Mexico, the Conqueror and afterwards Royal Governor of Guatemala, are seventeen in number, of which three only have been printed. They give an account of the reduction of the rich and powerful Kingdoms of the Zutugils, Quichés, and Kachiquels of Guatemala, and also of his campaign against the Pipils of Cuscatlan (now San Salvador), and his Expedition to Peru.

IV. Relacion muy circumstanciada, escrita al Rey, de los sucesos de Juan Vasquez de Coronado, en las Provincias de Nuevo Cartago y Costa

Rica en la Pacificacion y Descubrimiento de ellas, por el Cabildo de la Ciudad y Provincia de Costa Rica, en 12 de Diciembre, 1562.

A very circumstantial relation to the King of the proceedings of Juan Vasques de Coronado, in the Provinces of New Cartago and Costa Rica, and in their reduction and pacification, by the Municipality of the City and Province of Costa Rica, December 12th, 1562.

V. Relacion dirigida al Rey por Pedrarias Davila, de las Tierras, Costas y Puertos que estaban descubiertos en el Mar del Sur, desde la Villa de Bruselas que estaba poblado en el Golfo de San Lucar, hasta Neguepio que por otro nombre tambien se llamaba Cuzcatan, distancia de 200 leguas; año 1529.

Relation to the King of Spain, by Pedro Arias de Avila, concerning the lands, coasts, and ports which have been discovered in the South Sea, from the city of Brussles in the Gulf of San Lucar, to Neguepio, called also Cuzcatan, a distance of 200 leagues. Dated in the year 1529.

VI. Relation que en el Consejo Real de las Indias hizeo el Licenciado Antonio de Leon Pinelo, Relator de su Alteza, Sobre la Pacificacion y Poblacion de las Provincias del Manché i Lacandon, que pretende hazer Don Diego de Vera Ordoñez de Villaquiran, Cavallero de la Orden de la Calatrava, etc.; año 1638.

This is an account drawn up by the celebrated Antonio Leon Pinceo, author of the "Tratado de Confirmaciones Reales, etc," in his capacity of historical Secretary or reporter to the Council of the Indias, on the remarkable and even now but little known district, occupied by unconquered Indian tribes, which lies between Guatemala, Chiapa, Tabasco, and Yucatan. It gives a comprehensive summary of all that was known of this wide region and its inhabitants, at the time Pinelo wrote, and seems to have been compiled from original, and, as yet, unpublished, documents in the Archives of the Indies. These *relaciones* or Briefs were for the use of the Council exclusively, and only enough were printed to give a copy to each member. Probably no copy of the present document exists, except the one under notice, which seems to have belonged to Pinelo himself, as may be inferred from the MS. corrections and emendations which it bears, and which appear to have been made by his own hand.

VII. Carta dirijida al Rey de España sobre la Conquista y Pacificacion de la Provincia de Yucatan y sus poderosos Reyes, por el Fray Lorenzo de Bienvenida; año 1548.

VIII. Relacion de la Provincia de Honduras é Higueras, por el Obispo Don Cristoval de Pedraza, Obispo de Honduras, dirijida al Emperador, desde el puerto de Truxillo, con fecha de primero de Mayo, año 1547.

IX. Descripcion de las Islas Guanajas; parte de un Informe hecho en 1639, de orden del Presidente de Guatemala, por Don Francisco de Avila i Lugo, Gobernador i Capitan General de Honduras.

X. Relacion de la provincia y tierra de la Vera Paz, y de las cosas contenidas en ella, como son montes, fuentes, animales, aves, y plantas y arboledas, del numero de los pueblos y distancia de la Iglesias y fundacion de ellas, y de lo que cada uno tiene; y finalmente del numero de gente, sus lenguas, su policia y Xpiandad, desde el año de 1544, hasta este de 1575.

XI. Discurso de Felipe de Aniñon, sobre las utilidades y ventajas que resultarian de mudarse la Navegacion de Nombre de Dios y Panama al Puerto de Cavallos y Fonseca, año 1565.

Etc., etc., etc., more than one hundred in number.

ART. VII.—*Researches on the Platinum Metals;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy, New York.

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§ 1.

THE material which formed the subject of the present investigation was chiefly obtained from the United States Assay Office and from the Philadelphia Mint, and I am indebted for it to the kindness of Dr. Torrey and of Prof. Bache. Messrs. Cornelius of Philadelphia have also liberally presented me with about 600 grammes of the Siberian osmiridium—a supply which has been of great assistance and for which I desire to express my thanks. The samples obtained from the mint at different times and which had been subjected to different preliminary processes, varied greatly in appearance. In some cases the ore was in distinct scales rather whiter than the Siberian osmiridium; in a sample of this kind Dr. Genth detected distinct crystals, belonging to the rhombohedral system. Other specimens resembled a fine grey metallic sand, while others again (obtained from the sweepings of the Assay Office) presented a heavy grey powder. Nearly all the ores contained more or less iron mechanically mixed which could be extracted by the magnet or dissolved out by acids. Nitro-muriatic acid in particular acted powerfully upon many specimens, dissolving portions of the platinum metals as well as iron and even so far attacking the osmiridium itself as to occasion a distinct evolution of free osmic acid. In California the ore is, I believe, almost always associated with gold, from which it is of course impossible to separate it by washing. At the Assay office, in this city, the gold is melted with twice its weight of silver and the osmiridium allowed to settle. When the gold alloy is poured off, there remains a mass containing nearly all the osmiridium mixed with gold. This mass is fused repeatedly with silver and the last traces of silver and gold are finally removed by treatment with nitric and nitro-muriatic acid and washing. The osmiridium is sold to the manufacturers of gold pens who extract from it the excessively hard particles which serve for the points of pens: the rest is returned to the assay office. The amount of osmiridium obtained in this way does not exceed a few ounces in every million of dollars, and many samples of gold are entirely free from it. It cannot however be doubted that large quantities of the ore will be obtained whenever important practical applications of the metals contained in it shall create a demand.*

* Dr. Torrey has kindly furnished me with the following notes on the Californian osmiridium. "For the first year or two after the establishment of the United

The density of the osmiridium obtained from California varies greatly in different samples: in one specimen, composed of large dull white plates but slightly acted on by nitro-muriatic acid, the specific gravity as determined by Rose's method was found to be 19·352. No very definite conclusions can be reached however from such determinations, since, as Berzelius has remarked, the separate scales or grains have probably very different compositions. According to G. Rose, the density of the Siberian ore varies from 19·3 to 21·1. Dr. Torrey has found among the scales of the Californian ore some which could be flattened under the hammer; these were probably platin-iridium. In general, however, the scales are not malleable; some of a lead gray or bluish tint being with great difficulty cut by the emory dust employed by the gold pen makers. In color the scales vary from nearly silver white to dark gray.

§ 2.

The resolution of the ores of iridium, osmium, etc., and the separation of the different platinum metals from each other, have as is well known always been considered as among the most difficult problems with which the chemist has to deal. Though the researches of Wollaston, Berzelius, Wöhler and other chemists have thrown much light on the subject, and though Claus, in particular, in his elaborate "Beiträge zur Chemie der Platin-Metalle" has done much to free the chemical history of this group from the errors of his predecessors, I yet found that much remained to be done, especially as the Californian ore differs from the Siberian in the greater relative proportion of Ruthenium which it contains. This difference alone renders a different treatment of the ores necessary. In the course of the investigation which I have undertaken, I have been able to test upon considerable quantities of material, nearly all the methods of working the ores of osmium, etc., which have hitherto been employed. As the experience thus obtained has been at great expense of time and labor I will here give it as concisely as possible, believing that it will be useful to others, who may hereafter take up the same subject.

States Assay Office, the proportion of osmiridium in the California gold, did not exceed half an ounce to the million of dollars. Afterward, the proportion rapidly increased till the average was seven or eight ounces to the million of gold. Then for a year or more the quantity diminished, but for the last year it has been as large as ever. These differences depend upon the variable composition of the native gold, and the constant discovery of new diggings.

The grains of osmiridium, suitable for pens, are roundish and solid, not liable to exfoliate when struck or heated. They seem to have a different composition from the compressed and tabular crystals. The proportion of them is usually not more than a tenth of all the alloy, but it is sometimes as large as one-fifth.

The carefully selected grains used by the gold pen makers are so minute that from 10,000 to 15,000 of them are contained in a single ounce. The very best are worth at least $250 an ounce, and a cubic inch, which would be equal to about eleven ounces, is worth $2,750.

Fremy's* most recent method consists in roasting the ore in a current of air or oxygen at a strong red heat. Under these circumstances the osmium is in a great measure removed as osmic acid, while the other metals are more or less completely oxydized. The mass from which the osmium has been removed is then to be fused with nitre, after which the remaining osmium may be separated by distillation with nitric acid. Fremy gives a method for the separation of the other metals from each other, which however cannot yield these in a state of purity. The separation of the osmium by roasting, has undoubtedly the advantage of giving pure osmic acid in large quantity and at small expense of materials. On the other hand, this process is not applicable to all the varieties of osmiridium, while in those to which it does apply the roasting does not remove all the osmium, and consequently does not obviate the necessity of one or more subsequent fusions with powerful oxydizing agents. So far as the iridium, rhodium and ruthenium are concerned, it is better to oxydize at once as Claus recommends, by fusion with nitre and caustic potash. In an experiment which I made to test Fremy's process and in which I employed California ore in the form of fine gray sand and heated to full whiteness in a porcelain tube, I obtained after long heating but little osmic acid; the tube became clogged and broke, and after cooling I found that the ore had actually melted and presented a gray mass, having the shape of the tube in which it was fused. This mass resembled when broken a fine grained cast iron; it was very hard and distinctly crystalline upon those parts of the fracture nearest the surface. As the large scales of osmiridium from California do not melt before the flame of the compound blowpipe this result was very unexpected; it was doubtless owing to the large quantity of iron which the ore contained.

In a memoir published in 1835, Persoz† gave a method of working osmiridium by first converting the metals into sulphids. The ore is to be mixed with carbonate of soda and sulphur and then projected into a strongly heated earthen crucible. The crucible is then to be heated to whiteness, allowed to cool and broken. According to Persoz, the contents of the crucible consist of three layers, of which the lowest contains nearly all the sulphids of the platinum metals. The two lower layers are to be treated with water to dissolve the alkaline sulphids, and the remaining mass heated with oxyd of mercury which leaves oxyd of iridium—according to Persoz—while oxyd of osmium and metallic mercury are expelled.

* Comptes Rendus, xxxviii, 1008.

† Ann. de Chimie et de Physique, 55, 210.

Weiss and Doebereiner* confirmed the results of Persoz so far as the conversion of the platinum metals into sulphids was concerned. They recommended the fusion of the sulphids, after removing those of sodium and of iron by washing with water and chlorhydric acid, with carbonate of potash and saltpetre, so as to oxydize the sulphur and the platinum metals at the same time. By this process the ore is almost completely resolved in two operations.

On repeating these experiments with the California ore, I obtained the same results as to the formation of the metallic sulphids. After digesting the fused matter with chlorhydric acid and washing, there remained a greyish mass of crystalline scales, which resisted even boiling nitro-muriatic acid,—no smell of osmic acid being perceptible. These scales were however powerfully acted upon by fused caustic potash to which saltpetre was cautiously added, or by a mixture of carbonate and nitrate of potash, but the process could only be conducted on a small scale in consequence of excessive frothing which rendered it necessary to use very large vessels. Chlorine gas at a red heat exerted no sensible action upon the mixed sulphids.

The difficulties attending the fusion of the mixed sulphids with oxydizing agents may however be readily overcome by previously reducing them to the metallic state. This is most simply accomplished by a method suggested to me by Dr. Genth, which consists in evaporating the sulphids to dryness with a small excess of strong sulphuric acid and then igniting gently. A gray metallic sponge remains, which contains all the platinum metals with a small quantity of iron. It is easily reduced to a fine powder by rubbing in a mortar and may then be completely oxydized by Claus' method presently to be described. Nitro-muriatic acid acts very slightly upon this metallic mixture and I have not found it possible by this agent to remove an appreciable trace of platinum.

This process when carefully conducted gives good results but is not free from inconvenience. In the first place the treatment of the mixed sulphids with sulphuric acid must frequently be repeated twice in order to ensure the complete conversion of the sulphids into metals. Again the action of a mixture of caustic potash and saltpetre at a high temperature upon the finely divided metallic mass is violent and not free from danger when all the materials are heated together. The danger may be avoided by fusing the nitre and potash together and, after all frothing has ceased, projecting the metallic sponge little by little into the crucible, waiting in each case until the resulting action has ceased before projecting a fresh portion. I am of opinion that the pre-

* Annalen der Pharmacie, xiv, 15.

vious conversion of the platinum-metals into sulphids and subsequent reduction to the metallic state is upon the whole more inconvenient and requires more time than the direct resolution of the ore by fusion with an oxydizing mixture.

Experiments which I have instituted upon the effects of fusing the ore with steel, phosphorus, arsenic and sodium, led to no really valuable practical results. It is true that an alloy with steel can be obtained by fusion at a high temperature. Acids slowly dissôlve the iron in this alloy and leave the platinum metals in the form of a black powder which is attacked by nitromuriatic acid, though not completely dissolved. But the process is tedious and the results not very satisfactory.*

Wöhler's† method of resolving osmiridium, consists in passing moist chlorine over the ore mixed with common salt and heated to low redness in a glass or porcelain tube. This method is invaluable in analysis and gives excellent results in working the ore upon a small scale. In all cases however, several repetitions of the process are necessary for complete resolution or reduction to a soluble form. On the other hand, it can scarcely be doubted that this method could be advantageously employed upon the large scale, if vessels of porcelain of large size and of a proper shape could be obtained. Such vessels might be constructed in the form of long and flattened ellipsoids, furnished at each extremity with wide tubes several inches in length, and would be of great utility in various chemical processes. No process of fusion with oxydizing agents compares with Wöhler's method in point of elegance, as no iron or other impurities afterward to be removed, are introduced by the process itself.

Fritzsche and Struve‡ treat the ore with a mixture of equal parts of hydrate and chlorate of potash, by which a more or less complete oxydation is effected, without any sensible evolution of osmic acid. The temperature required in this process is not high, but large vessels must be employed as the mixture froths very much at first. The process in question has not appeared to me to possess any sensible advantage over that of Claus, which is moreover less expensive and can be carried out with smaller vessels.

Claus'§ method of resolving the ore consists in fusing for an hour, at a red heat, a mixture of one part of ore with one part

* Since the above was written the elaborate memoir of Deville and Debray on the platinum metals has appeared. (Ann. de Chimie et de Physique, 3d, lvi, 385.) I have not however been able to repeat any of the processes for subdividing or oxydizing osmiridium given by these chemists but consider it probable that the subdivision of the ore accomplished by fusion with zinc may be simpler than that which I have described above.

† Pogg. Annalen, xxxi, 161.

‡ Journal für prakt. Chemie, xxxvii, p. 483.

§ Beiträge zur Chemie der Platin-metalle. Dorpat, 1854.

of caustic potash and two of saltpetre. The fused mass is to be poured out upon a stone, allowed to cool, broken into small pieces or powdered, and then introduced into a flask which is to be filled with cold water and allowed to stand for twenty-four hours. The clear deep orange red solution of osmate and ruthenate of potash is then to be drawn off by means of a syphon, and the black mass remaining again washed in the same manner. The finely divided oxydized portion of the insoluble matter may now be separated from the unattacked ore by diffusion in water and pouring off, after the subsidence of the heavier ore. The unattacked ore is then to be fused a second time with potash and saltpetre and treated as before. Claus asserts that he has been able in this manner to resolve the Siberian osmiridium completely in two operations.

I have not always been so fortunate with the raw California ore, even when in a finely divided state. On the contrary, after three or four successive fusions there usually remained a large quantity of black matter insoluble in aqua-regia. In one operation with 500 grammes of ore only 200 grammes were rendered soluble by two fusions with potash and saltpetre. I employ at present the method of Claus with several modifications which I deem essential. The ore, which is usually very impure, is in the first place to be fused with three times its weight of dry carbonate of soda. The fused mass after cooling is to be treated with hot water to remove all the soluble portions and then the lighter portions are to be separated by washing from the heavy unattacked ore. In this manner the greater part of the silica and other impurities present may be removed. A previous purification of this kind is not indispensable and may be omitted altogether when the ore is in plates or large grains, but it is very desirable when the ore is fine powder and greatly facilitates the subsequent action of the oxydizing mixture. Claus recommends the purification of the ore by boiling with a solution of caustic potash. It is certain that a much larger portion of the ore is resolved by two successive fusions with potash and nitre after previous purification by fusion with soda and washing. By cutting off the top of a mercury bottle a wrought iron crucible is obtained in which 600 grammes of osmiridium may be fused at one operation with potash and saltpetre as above. There is usually little or no foaming and if any occur it may easily be checked by stirring with an iron rod. No sensible quantity of osmic acid is given off during the process, which with a little care is entirely free from danger. In this manner, I have worked up 1500 grammes of ore in a few hours in three successive operations.

Claus' method of treating the fused mass to separate ruthenium and osmium is liable to two sources of inconvenience. In

the first place, the quantity of water required to dissolve out the soluble portions is very large, and the subsequent treatment of such bulky solutions by distillation with acids, tedious—very large retorts being necessary. In the next place, it is impossible in this way to avoid exposure to the vapor of osmic acid, especially in transferring the solutions from one vessel to another. I therefore prefer the following process which leaves nothing to be desired in point of safety or convenience. The fused mass is to be broken into pieces with a hammer and brought into a clean iron pot—a common skillet with a long handle answers this purpose extremely well. Boiling water containing about one-tenth of its volume of strong alcohol is then to be added and the whole is to be boiled over an open fire until the fused mass is completely disintegrated. The osmate of potash is in this manner reduced to osmite $KOsO_4$, while the ruthenate of potash is completely decomposed, the ruthenium being precipitated as a black powder—probably a mixture of RuO_2 and Ru_2O_3 or of the hydrates of these oxyds. It is advantageous, after boiling for some time, to pour off the supernatant liquid with the lighter portions of the oxyds and boil a second time with a fresh mixture of alcohol and water. In this manner we obtain a solution of osmite of potash, a large quantity of black oxyds and a heavy black and coarse powder. This last consists chiefly of undecomposed ore mixed with a small quantity of the oxyds of iridium &c., with scales of oxyd of iron from the crucible and, if the ore has not been previously purified, with the impurities of the ore itself. The greater specific gravity of this residual mass renders it very easy to pour off from it the mixture of black oxyds with the solution of osmite of potash and alkaline salts. This solution with the suspended powder is to be poured into a beaker and allowed to settle. The heavy black powder remaining in the iron pot is then to be perfectly dried over the fire and fused a second time with potash and saltpetre as before. The fused mass is to be treated exactly as after the first fusion. The heavy portions remaining after this operation may be fused a third time with the oxydizing mixture. When however the ore has been previously purified by fusion with carbonate of soda, or when it was originally in the form of clean scales, the heavy portion remaining after two successive oxydations will be found to consist chiefly of scales of oxyd of iron.

The solutions containing osmite of potash and alkaline salts are to be carefully drawn off by a siphon from the black oxyds which have settled to the bottom of the containing vessels. The oxyds may then be washed with hot water containing a little alcohol and introduced into a capacious retort. By this process, when carefully executed, no trace of osmic acid escapes—an advantage not to be despised, as the deleterious effects of this body

upon the lungs have not been exaggerated and too much care cannot be taken to avoid inhaling it.

The solution of alkaline salts contains only a portion of the osmium in the ore. The other portion exists in the mixture of oxyd and must be separated by distillation. For this purpose the retort should be provided with a safety tube passing through the tubulure and with a receiver kept cold, and connected by a wide bent tube with a series of two or three two-necked bottles containing a strong solution of caustic potash with a little alcohol and also kept cold. All the tubulures and connections must be made perfectly tight. Strong chlorhydric acid is then to be cautiously poured into the retort through the safety-tube in small portions at a time. The reaction which ensues is often violent; great heat is evolved and a portion of the osmic acid distils over immediately and condenses in the receiver in the form of colorless needles. When a large excess of acid has been added, the action has entirely ceased and the retort has become cold, heat may be applied by means of a sand bath. The osmic acid gradually distils over and condenses in the receiver and in the two-necked bottles. Especial care must be taken that the beak of the retort is not too small at the extremity as it may otherwise become completely stopped up with the condensed osmic acid. The same applies to the tubes connecting the receivers and two-necked bottles. The distillation should be continued for some time after osmic acid ceases to appear in the neck of the retort; when this has once become hot the acid condenses and passes into the receiver in the form of oily drops.

When the distillation is finished the retort is to be allowed to cool and then separated from the receiver which is to be immediately closed with a cork. By gently heating the receiver in a water-bath the contained osmic acid may be driven over into the two-necked bottles where it condenses in the alkaline solution and is reduced by the alcohol to osmite of potash. The solution thus obtained may be added to that obtained directly from the fused mass of ore and on evaporation in a water-bath and cooling will yield crystals of osmite of potash, the salt being but slightly soluble in strong saline solutions. The mother liquor from the crystals contains only traces of osmium and may be thrown away as worthless.

The dissolved portions drawn off from the retort have a very dark brown-red color. The solution is to be evaporated to dryness, redissolved in hot water and again evaporated, after adding a little chlorhydric acid, and this process repeated till no smell of osmic acid can be perceived. A cold and saturated solution of chlorid of potassium is then to be added in large excess. This dissolves the chlorids of iron and palladium which may be present, leaving platinum, iridium, rhodium and ruthenium as double chlorids insoluble in a strong solution of the alkaline chlorid.

The undissolved mass is to be well washed with a saturated solution of chlorid of potassium which, for reasons hereafter to be mentioned, is preferable to salammoniac. In this manner nearly the whole of the iron and palladium may be removed, while any insoluble impurities contained in the ore remain with the mixed double chlorids.

New York, Oct. 31st, 1860.

(*To be continued.*)

ART. VIII.—*On a Method of Producing Stereographs by Hand;* by OGDEN N. ROOD, Prof. of Chemistry in Troy University.

[With a Stereoscopic diagram.]

SIR DAVID BREWSTER in his *Treatise on the Stereoscope*, (London, 1856) page 135, after describing a method of projecting the picture seen by one eye, of a symmetrical, geometric solid, and of obtaining by reflexion from a mirror a drawing of its stereoscopic companion, states: "When the geometrical solids are not symmetrical, their dissimilar pictures must be taken photographically, from models, in the same manner as the dissimilar pictures of other solids."

Upon page 200 of the same work he states, that though apparatus may be photographed *directly*, yet that stereoscopic diagrams, can only be executed by the use of models made of *wire*, which are to be photographed in the usual way.

The same author in the article Stereoscope, *Encylopædia Britannica*, vol. xx, 1859, p. 690, writes: "As no artist, however skillful, is capable of executing two pictures of any individual object, or group of objects, as they are seen by each eye separately, the stereoscope was of little value before the art of photography enabled us to take such pictures with the most perfect accuracy."

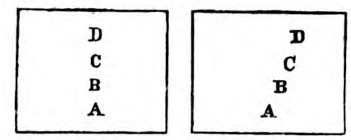
In addition to these statements, which would seem to imply the impossibility of producing stereographs by hand, I have not been able to learn from scientific friends nor from professional photographers, that any process is now in use to effect this end, except the laborious and imperfect one of geometrical *projection*. Under these circumstances, I venture to describe a simple method of drawing stereographs, which possibly may supply a want in this department.

When we examine attentively a photographic stereograph with the aid of micrometrical measurements, and adopt the left-hand picture as a *standard of comparison*, we find that the right-hand picture is an exact reproduction of it, with one important exception; viz., that in the right-hand picture the position of an object, a little more distant from the spectator than the immediate foreground, is *shifted* a small distance toward the right

hand; objects farther back, have their position shifted still more to the right hand, &c.

This is illustrated by fig. 1, where A is in the immediate foreground, and D in the background.

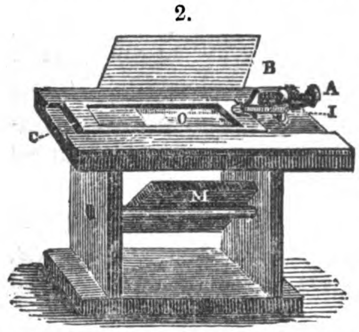
1.



Now if we had a single drawing in perspective, of a house for example, and could produce a fac-simile of it, this would evidently answer for the left-hand picture. If we could again reproduce this drawing on the right hand of the slide, with all the objects or points in it back of the immediate foreground, *shifted* to the right hand the proper distances, we should have a pair of pictures, which when combined in the stereoscope would give relief.

To accomplish this is the object of the machine seen in fig. 2.

2.



It consists of a board, 10 in. by 14, having a square opening O, in its centre 5 inches wide; this is covred by a plate of glass which is let into the wood and lies even with its upper surface. The slider C is moveable in the direction indicated in the figure: its motion is effected by the screw A, which acts against the India rubber band I: the screw and its support are removable at pleasure. The mirror M serves for illumination; the shade B moves on hinges, and regulates the amount of light which falls on the paper while the drawing is being made.

To produce a stereograph, the object or objects to be represented are drawn in perspective with ink on writing paper; this is oiled to render it transparent, the excess of oil is removed, and the drawing is attached with a drop or two of gum arabic to the glass plate, which is completely exposed by the removal of the slider. The under side of the latter is covered with ordinary writing paper or with thin paper, and it is slid into the machine till the drawing is seen under its left half, the screw having been previously removed. In this position it is fastened securely by a screw at C, and the drawing is traced slowly, line by line, until as perfect a fac-simile as can be made by hand has been produced; this is the left-hand picture.

The slider is now moved toward the right hand a distance of 2·6 in. and the screw with the India rubber band attached.

An object, or a small portion of an object, in the *immediate foreground* is now traced, then the screw is turned slightly so as throw the next object, or the remainder of the first object, slightly toward the right hand where it also is drawn, &c. Thus we advance slowly toward the background, turning the screw

each time that depth is to be represented. This in practice is a very simple operation, and if the displacements toward the right hand have been rightly proportioned the effect produced is good.*

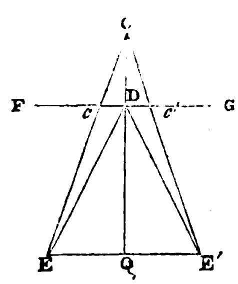
The process is also a rapid one, for it consists only in making two tracings.

The question now arises as to the total amount of displacement allowable, and as to its proper distribution.

If a number of stereoscopic photographs are examined it will be found that in those where the sum of all the displacements is not more than one or two tenths of an inch the two images are readily united, and a good general effect produced, while in those where this quantity is as great as three or four tenths, difficulty is experienced in effecting the union.

Taking then ·2 of an inch as the maximum total displacement allowable, the method of its distribution from foreground to background can be calculated in the following way:

3.



Let EE′ be the distance between the eyes $=2{\cdot}5$ in., $QD=6$ in. the nearest distance of distinct vision; $CD=1$ in. A small object being placed at D and another at C, the eye E sees the two objects projected in the line FG at c and D; the eye E′ sees the same objects at D and c'. Here the total displacement, adopting the picture seen by the left eye as a standard of comparison, is equal to the distance cc'. With the proportion:—

$$QC : EQ = (1{\cdot}25 \text{ in.}) :: CD : cD = \frac{cc'}{2}$$

we have at once the value of this quantity. In like manner this displacement on the line FG for 2, 3, 4 or any number of inches from Q is readily calculated.

As an example I subjoin the following table applicable to small models:

For the 19th inch above 6 inches,

	Total displacement.	
or for the 25th inch, . .	1·900 inch,	= 0
26 "	1·922 "	" ·022
27 " . .	1·940 "	" ·040
28 "	1·960 "	" ·060
29 " . .	1·980 "	" ·080
30 "	2·000 "	" ·100
31 " . .	2·016 "	" ·116
32 "	2·030 "	" ·133
33 " . .	2·045 "	" ·145
34 "	2·058 "	" ·158
35 " . .	2·072 "	" ·172
36 "	2·082 "	" ·182

* It will sometimes happen that portions of objects in the background which were hidden in the left picture are brought into view in the right hand representation. This offers no practical difficulty, for the indicated additions are readily made.

As in using this table objects in the extreme foreground are supposed to be 25 inches distant from Q, we have for them not a displacement 1·900 in. but 0: for the 26th inch, viz. the 1st inch of depth in the picture the quantity ·022, &c. Thus if we know the distance from the spectators of the objects to be represented, they can be located on the stereograph. In the same manner tables are constructed which apply to objects placed at greater distances from the eye. Indeed after some practice very tolerable stereoscopic representations of many objects can be made without reference to such tables. (See drawing.)

This process was originally devised by me for the production of stereoscopic representations of optical phenomena, which when well executed form almost a substitute for the real illustrations.

Photography for obvious reasons is not well adapted to this class of objects.

By coloring *differently*, corresponding parts of two stereoscopic pictures, or by the application of color to only one, the other being allowed to remain white or black, or by completing certain parts of the drawing only in one picture, many appearances connected with subjective optical phenomena can be represented with a degree of perfection unattainable in a single picture.

Prof. H. W. Dove, (*Farbenlehre*, p. 166) has studied the effects produced by coloring two stereoscopic drawings differently, though I am not aware that he has made this application of the results he obtained.

By slightly rotating the instrument around a line perpendicular to its axis, as was remarked to me by Prof. B. Silliman, Jr., many of these effects are greatly enhanced. The phenomena of complementary colors, and many other facts of physical optics not otherwise within the reach of most students, may also, as the same gentleman has suggested to me, be rendered intelligible by the stereoscope without the use of costly apparatus. The stereoscope is thus capable, in the hands of an expert teacher, of a far wider range of use than was at first seen.

At the suggestion of Dr. W. Gibbs, I have also made a few stereoscopic drawings of crystal models: these can be drawn by this instrument with perhaps greater facility and rapidity than any other class of objects.

The accompanying stereoscopic diagram was drawn with my apparatus without reference to tables.

Outline sketches of every description, stereoscopic drawings of ideal objects or of objects not in the possession of the draftsman, are by this process readily executed—problems evidently beyond the power of photography.

Finally the drawings thus made can be transferred to wood and stone and reproduced by the thousand.

Troy, Oct. 11th, 1860.

ART. IX.—*Note on Sources of Error in the Employment of Picric Acid to detect the Presence of Potash;* by M. CAREY LEA, Philadelphia.

[Read before the Am. Assoc. for the Adv. of Sci., at Newport, August, 1860.]

PICRIC acid enjoys a high reputation as a test for potash. Employed in its alcoholic solution, or as soda or ammonia salt sometimes as magnesia salt, it gives with potash solutions a dense yellow crystalline precipitate. If the solution containing potash be very dilute, the precipitate may not make its appearance till after some hours repose, and it then forms long delicate needles.

Rose remarks that this reagent "is even more sensitive than the solution of chlorid of platinum." In his summing up, he observes, that of the various reagents, chlorid of platinum, tartaric acid, picric acid, perchloric acid, sulphate of alumina and hydrofluosilicic acid, the latter is insufficient to distinguish between potash and soda; and that the chlorid of platinum and sulphate of alumina give the same reactions with ammonia as with potash.* No qualification is made with respect to the certainty of the indications afforded by picric acid. Plattner makes the same observation as to the greater sensitiveness of picric acid compared with bichlorid of platinum and equally without qualification as to its reliability.†

I therefore believe that the remarkable insolubility of otherwise soluble alcaline picrates, in alcaline solutions has not been before pointed out. If an alcoholic solution of picric acid be poured into a solution of carbonate of soda, it occasions an immediate dense yellow precipitate, not to be distinguished in appearance from a precipitate of picrate of potash, and liable to be mistaken for it with the greatest facility. The picrate of soda formed in the case just mentioned is the most soluble of all the alcaline picrates, and *à priori* we should not expect to find it precipitated under these circumstances: an aqueous solution of picrate of soda added to one of carbonate of soda acts in precisely the same manner.

To ascertain if these reactions were extended to various compounds of picric acid, examinations were made which gave with the following results:

Alcoholic solution of picric acid added to—

solution of carbonate of ammonia, gave an immediate dense yellow crystalline precipitate.

" carbonate of soda gave not so instantaneous a precipitate, but one which after standing became even more dense.

* Rose, Handbuch der Analytischen Chemie, 1r Band, 6–10 S.

† Plattner, die Probirkunst mit dem Lothrohre, 3d Ed. p. 178.

Aqueous solutions of picrate of soda gave with

solution of carbonate ammonia,	abundant precipitates.
sulphate of ammonia,	abundant precipitates.
carbonate of soda,	abundant precipitates.
phosphate of soda,	slight precipitate.

Aqueous solution of picrate of ammonia gave with

solution of carbonate of ammonia,	abundant precipitates.
" sulphate of ammonia,	abundant precipitates.
" carbonate of soda,	abundant precipitates.
" phosphate of soda,	none.

Aqueous solution of picrate of magnesia gave with

solution of carbonate of soda,	abundant precipitates.
" carbonate of ammonia,	abundant precipitates.

When the alcaline solutions to be tested are otherwise than very dilute there is absolutely no difference in the appearance of the precipitates. When the amount of precipitate is small, the following differences may be observed:

The potash precipitate forms longer needles, and when these are found only after standing, or when the precipitate is redissolved by heat and allowed to crystallize by slow cooling, they exhibit a beautiful play of red and green colors.

The soda salt is of a lighter and brighter yellow than either the potash or ammonia salt. Its needles are also shorter than those of either of the other compounds, and when the precipitate has been redissolved by heat, and allowed to crystallize by slow cooling, they tend to agglomerate themselves together in spherical masses. This is a very marked character, and when exhibited, is unmistakable, but is not always shown.

The ammonia salt when crystallized in quantities is very distinct in appearance from the potash salt, but when thrown down in small portions, even by slow crystallization, cannot be distinguished from it with certainty. The prisms are flatter, but these differences are not apparent in very slender needles. The play of colors which the ammonia salt exhibits to a less degree than the potash, disappears entirely in the soda salt.

The above reactions indicate that extreme caution must be used in employing picric acid as a test for potash. The precipitates above described do not redissolve in any excess of the picrate, or of picric acid; nor is it to be supposed that concentrated alcaline solutions are necessary to cause them—on the contrary, in many cases, very dilute ones are sufficient. To determine within what limits such reactions are produced, the following trials were made:

A. Dilution of the alcaline solutions. Limits obtained,

(I.) With carbonate of soda,

A solution containing 5 per cent anhydrous carbonate of soda gave
with alcoholic solution of picric acid, an immediate abundant precipitate, in 10 minutes the tube could be inverted without spilling the contents.
with solution picrate of soda, an immediate precipitate becoming in the course of an hour a very dense one.

A solution containing $2\frac{1}{2}$ per cent carbonate of soda gave
with alcoholic picric acid, a slight precipitate increasing very much by standing, sò that after 18 hours the tube could be inverted without spilling the contents.
with picrate of soda, none.

A solution containing 1 per cent carbonate of soda gave
with alcoholic picric acid, slight precip. after 18 hours repose.
with picrate of soda, none.

(II.) With sulphate of ammonia,

A solution containing 5 per cent anhydrous sulphate ammonia gave
with alcoh. picric acid, immediate dense precip.
" picrate soda " " "

solution containing $2\frac{1}{2}$ p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.

solution containing 1 p. c. sulph. ammonia gave
with alcoh. picric acid, immediate dense precip.
" solution picrate soda, immediate slight precipitate. The solution on standing gave a beautiful crystallization of long needles with bright play of colors, exactly resembling the reaction of potash salts.
" picrate magnesia, by long standing, a very faint precip.
" picrate ammonia, none.

solution containing $\frac{1}{250}$ anh. sulphate ammonia gave
with alcoh. picric acid, after a short interval an abundant precipitate.

solution containing $\frac{1}{500}$ anh. sulph. ammonia gave
with alcoh. picric acid, after a short interval, a considerable precip.

solution containing $\frac{1}{1000}$ anh. sulph. ammonia gave
with alcoh. picric acid, no precipitate, even after twenty-four hours' repose.

B. Limits obtained with respect to indications of diluted solutions of alcaline picrate.

A solution of picrate of ammonia in 200 parts water gave—with an equal volume of strong solution of carbonate of ammonia, an immediate precipitate of small yellow needles—in 10 minutes a considerable quantity settled at the bottom of the vessel.

A solution of same salt in 400 water gave with an equal volume of solution carbonate ammonia, signs of a precipitate in a few minutes, and after some hours an appreciable quantity settled at the bottom of the vessel.

With 1 part picrate ammonia in 800 water no precip. was produced by solution of carb. ammonia even after 24 hours' repose.

The conclusion to be drawn from these results is,

That alcoholic solution of picric acid or aqueous solution of picrate of soda will produce a precipitate in almost any alcaline

solution, whether of soda, ammonia or potash, except under circumstances of great dilution, especially if allowed to repose for 24 hours.

That picrate of ammonia and picrate of magnesia give the same results, but in a less degree.

That picric acid is therefore wholly unreliable as a test for potash; the results obtained being such as would tend altogether to mislead those who are not extremely familiar with the appearance of the precipitates, and that in some cases the results are so deceptive that even eyes most familiar with these reactions might be deceived; for example, in the result obtained above by testing a solution containing 1 per cent. sulphate of ammonia with solution of picrate of soda. In this case a crystallization of picrate of ammonia was obtained perfectly simulating that of the potash salt.

Picric acid is in fact a better test for soda, than for potash, because with a soda solution it gives a precipitate which redissolved by heat generally (but not always) gives a characteristic spherically radiated, bright canary yellow crystallization, whereas the precipitate obtained from a potash solution can never be positively distinguished by its appearance from that afforded by an ammonia solution, and we have just seen that a solution containing $\frac{1}{200}$ of sulphate of ammonia or even less, is capable of producing such a precipitate.

Philadelphia, Feb. 23d, 1860.

ART. X.—*On a Series of New Combinations of Ammonia, Picric Acid and Metallic Bases;* by M. CAREY LEA.

[Read before the Am. Assoc. for the Advancement of Sci., at Newport, Aug. 1860.]

IN a paper published in this Journal, vol. xxvi, 379, for 1858, I described two compounds of picric acid and ammonia with copper and nickel respectively, and mentioned their instability and the great difficulty of obtaining them in a state of tolerable purity. Since then I have found that many other metals form compounds of a similar nature, and have succeeded in obtaining several of them sufficiently pure for approximate analysis. The results obtained are given below—other investigations are in progress and I hope to communicate them hereafter.

When a metallic salt is precipitated by ammonia, and a large excess of the precipitant added, a more or less complete solution of the precipitate is frequently obtained, especially if a considerable quantity of ammoniacal salt be present. I have found that these ammoniacal solutions when treated with an alcaline picrate, for the most part yield an immediate precipitate containing

the elements of a metallic picrate united with those of ammonia. These precipitates are often very beautiful, they are generally yellow or yellowish, somewhat soluble in the mother liquid, or in strong ammoniacal solutions by aid of heat, nearly insoluble in water and decomposed by it very readily, especially if it be present in quantity, or heat be applied. Thrown on a filter and washed, the picric acid, ammonia, and some portion of undecomposed salt in solution pass through, while the greater part of the metallic oxyd remains on the filter and with sufficient washing is perfectly freed from picric acid and ammonia, and presents the appearance of a pure hydrate.

The analyses of these substances were made in the following manner. It was found desirable that before the ammonia and metallic oxyd were determined, the whole of the picric acid should first be removed. This was effected by adding chlorhydric acid to a weighed quantity of the substance carefully dried, and evaporating to dryness at a gentle heat. Ether, which must be anhydrous or nearly so, was added in the proportion of 15 to 18 grammes to ·6 or ·7 gms. of the salt used, detaching the dry crust and breaking it up to powder with a glass rod that every part might be brought thoroughly in contact with the ether. After standing ten minutes the ether was poured off, a fresh quantity added, and a larger beaker was inverted over that which contained the substance undergoing analysis. After a lapse of three or four hours the liquid was poured off, a third, and, if necessary, a fourth, quantity added in the same way. The decantation is effected with the greatest ease, as, if the ether is sufficiently strong, the chlorids remain nearly or quite dry at the bottom. It was found that by this means the picric acid could be separated with sufficient exactness to afford a tolerably correct estimation of its quantity, a careful trial with a weighed quantity of perfectly pure picric acid showed that the result fell a little under the truth by reason of a small loss arising from minute portions of the acid remaining undissolved. On the other hand, no chlorids are dissolved when the operation is properly performed: the etherial solution evaporated to dryness, and the residue dissolved in water was not troubled by solution of nitrate of silver.

The operation requires nice manipulation, otherwise the loss of picric acid is considerable, and if the ether be not sufficiently anhydrous, portions of the chlorids may be removed by it.

In this manner the quantity of picric acid was determined, and from it was calculated the quantity of the group $C_{12}H_2N_3O_{14}$, or picric acid minus the equivalent of hydrogen which is replaceable by a metallic oxyd; in other words, the group which by union with a base forms a picrate, or by union with hydrogen forms picric acid. From the residue undissolved by the ether, the ammonia was determined either by distillation with solution of caustic soda, or by precipitation with bichlorid of platinum.

From another portion the metallic oxyd was found by appropriate means.

As far as examined, the ammonia-picrates all contain more than one equivalent of ammonia, and are represented either by the formula:—

$$2NH_3MO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O \text{ or } 3NH_32\left[MO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O\right].$$

Ammonia-picrate of silver.

Nitrate of silver dissolved in water and treated first with excess of ammonia, and the resulting clear solution mixed with cold saturated solution of picrate of ammonia gives immediately an abundant highly crystalline light yellow precipitate of ammonia-picrate of silver, which is to be thrown upon a filter, thoroughly washed with dilute ammonia, and dried in vacuo over sulphuric acid.

It is to be observed that in the formation of this, as well as of all the other salts here described, the metallic solution must invariably be in excess to check as far as possible the precipitation of picrate of ammonia together with the compound sought. I have shown in a paper intended to be read at the same time as this,* that if an alkaline picrate be poured into an alkaline solution, a precipitate of alkaline picrate takes place. When the alcaline solution is strong the precipitate is immediate, and in the ammoniacal solutions used in the preparation of these salts any excess of alkaline picrate would fall with the ammonia-picrate. Even with every precaution, it is difficult and in some cases apparently impossible to obtain the ammonia-picrate perfectly free from this impurity.

Analysis.

·4245	substance gave	·2632 picric acid.
·5865	" "	·3600 " "
·4245	" "	·1577 chlorid of silver.
·5865	" "	·2177 " "
·3788	" "	·4932 chloroplatinate of ammonia.

This leads to the formula:—

$$2NH_3AgOC_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$ - - -	61·62	61·73	61·11	61·42
Ag - - - - - - -	29·19	27·96	27·94	27·95
$2NH_3$ - - - - -	9·19	9·93		9·93
	100·00	99·62		99·30

* See page 75.

The silver falls below, and the ammonia exceeds the calculated amount in consequence of the impossibility of obtaining the salt quite free from admixed picrate of ammonia.

This beautiful salt appears to be one of the most permanent of this very unstable class of substances. It dissolves readily in hot water containing ammonia, sparingly in cold, and crystallizes in fine needles from the hot solution. Heated on platinum foil it detonates and leaves a brilliant spot of metallic silver.

Ammonia-picrate of copper.

A cold saturated solution of picrate of ammonia added to an ammoniacal solution of sulphate or nitrate of copper, immediately throws down an abundant precipitate which after washing with strong solution of carbonate of ammonia and afterward with dilute ammonia exhibits a beautiful pale greenish yellow color with a shade of red through it. It is in fine scales and much resembles the dust of the wings of butterflies.

Analysis gave for this salt a constitution similar to that of the silver salt.

·6059	gms.	substance	gave	·4652 picric acid.
·9310	"	"	"	·1279 oxyd of copper.
1·4240	"	"	"	·1577 metallic copper.
·6059	"	"	"	·2190 chlorhydrate of ammonia.

The copper was determined in the one case by precipitating the cupric solution while boiling with hyposulphite of soda, dissolving in aqua regia, evaporating to dryness, redissolving in dilute chlorhydric acid, and precipitating with distilled zinc and estimating as metallic copper—in the other by precipitating at 212° by caustic soda.

These results lead to the formula:—

$$2NH_3CuO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O.$$

Dried over sulphuric acid in vacuo:—

	Calculated.	Found. 1.	2.	Mean.
$C_{12}H_2N_3O_{14}$	77·63	76·44		76·44
Cu	10·79	10·97	11·07	11·02
$2NH_3$	11·58	11·52		11·52
	100·00			98·98

In an experiment to ascertain whether all the moisture was removed by drying in vacuo over SO_3, a quantity of about two grammes by exposure to a temperature of 210° to 212° for 9 hours in the exsiccator lost a little less than one and a half milligrammes.

Heated on platinum foil the ammonia picrate of copper explodes with some violence and with a dazzling light.

Ammonia-picrate of Cobalt.

To a solution of protochlorid of cobalt prepared from chlorid of purpureo-cobalt in the manner recommended by Gibbs and Genth in their interesting and valuable paper on the ammonia-cobalt bases, a large excess of ammonia was added, and to the filtrate, cold saturated solution of picrate of ammonia. An abundant highly crystalline precipitate falls at once, which after drying is yellowish green: while moist decomposes with great facility with separation of cobaltous oxyd.

·6293	substance gave	·4784	picric acid.
·6075	" "	·4594	" "
·6067	" "	·1641	protosulphate of cobalt.
·5416	" "	·1475	" " "
·6075	" "	·2065	chlorhydrate of ammonia.

which results lead to the formula:—

$$2NH_3CoO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O+HO.$$

	Calculated.	Found. 1.	Found. 2.	Mean.
$C_{12}H_2N_3O_{14}$	75·87	75·69	75·29	75·49
Co	9·82	10·13	10·29	10·21
$2NH_3$	11·32	10·81		10·81
HO	2·99			
	100·00			

This salt is much more unstable than the foregoing, and undergoes a commencement of decomposition in washing: even when this part of the operation is performed with great care, using carbonate of ammonia and dilute liquid ammonia, a portion of picrate of ammonia is washed through, and as cobaltous oxyd is not easily soluble in ammoniacal solutions, it is not easily removed by washing with such. It is also probable that more or less cobaltous oxyd is thrown down with the precipitate, as the latter at the first moment crystalline, becomes quickly more and more curdy—and ammoniacal solution of cobalt by mere dilution with water throws down a bright green precipitate. In the preparation of the ammoniacal solution, it is better to drop a strong solution of cobaltous chlorid into a large excess of ammonia.

Like the foregoing this salt explodes by heat.

Ammonia-picrate of Zinc.

To a solution of pure sulphate of zinc, chlorhydric acid was added in sufficient quantity to prevent precipitation by the sub-

sequent addition of ammonia in excess. To the clear solution, a hot, strong solution of picrate of ammonia was added. Immediately the whole became nearly solid with beautiful yellow needles and scales—the beaker was rapidly cooled by cold water, the contents thrown on a filter, and washed first with a solution of carbonate of ammonia mixed with caustic ammonia, and finally with dilute caustic ammonia alone.

The splendid gold yellow mass of interlaced needles and scales, was more or less decomposed, even by the most careful washing, so that the brightest and purest parts only could be taken for analysis, nor were even these satisfactory.

$C_{12}H_2N_3O_{14}$	mean of 5 determinations,	81·26
NH_3	" 3 "	9·06
Zn		10·08
		100·30

The formula $3NH_3 \frown 2\left[ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.\right]$ requires:—

$2C_{12}H_2N_3O_{14}$	79·692
$3NH_3$	8·913
2Zn	11·395
	100·00

The salt examined may be either this compound containing admixed picrate of ammonia, or may be a mixture of:—

$$2NH_3\frown ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O, \text{ with}$$

$$NH_3\frown ZnO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

The fact that when a strongly acid solution of zinc-chlorid is supersaturated with ammonia, the compounds $2NH_3$ ZnO HCl and NH_3 ZnO HCl successively crystallize out, speaks in favor of the latter hypothesis.

Ammonia-picrate of Cadmium.

The cadmium salt is obtained and purified in exactly the same manner as the zinc, which it nearly resembles: it is however not so bright in color, but pure canary yellow. Like the zinc salt it redissolves in its mother liquid by heat without decomposition, but like almost all the compounds here described, when washed with pure water on a filter, the picric acid and ammonia wash through. A greyish white residue of oxyd of cadmium remains behind.

Heated on platinum foil, the salt deflagrates with a beautiful green light.

·7170	substance gave	·5247	picric acid.
·6622	" "	·4877	" "
1·1459	" "	·8452	" "
·6496	" "	·1653	sal ammoniac.
1·1459	" "	·2945	" "
·6045	" "	·6289	chlorplatinate of ammonia.
·7321	" "	·1501	cadmium oxyd.

These results lead to the formula:—

$$3NH_3\frown 2\left[Cd\,O.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.\right]$$

	Calculated.	Found. 1.	2.	3.	Mean.
$2(C_{12}H_2N_3O_{14})$	73·67	73·44	72·86	73·31	73·20
$3NH_3$	8·24	8·10	8·17	7·93	8·07
2Cd	18·09	17·94			17·94
	100·00				99·24

It seems however not improbable that this substance may be a mixture in nearly equivalent quantities of the salts:—

$$NH_3\frown CdO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O \text{ and } 2NH_3\frown CdO.C_{12}\begin{matrix}H_2\\3NO_4\end{matrix}\Big\}O.$$

for reasons similar to those mentioned in the case of the zinc salt.

Ammonia-picrate of Chromium.

This salt is easily obtained from an ammoniacal solution of chromoxyd which may be prepared in the following manner:

Three grammes of potash chrome alum are dissolved in water by boiling, the solution removed from the fire and 14 c. c. of pure concentrated sulphuric acid and 90 c. c. of liquid ammonia added. A strongly alkaline beautiful purple solution is thus obtained which may be preserved in well stopped vessels quite filled, for a considerable time.*

To a solution prepared in this manner, a strong hot solution of picrate of ammonia, not in excess, is to be added. Some precipitation follows at once which increases very much as the solution cools. The precipitate is thrown on a filter and washed with dilute liquid ammonia. It consists of splendid green metallic looking scales which if heated with a considerable quantity of water, even strongly ammoniacal, are decomposed with

* While studying the chromium salt, I met with Frémy's "Investigation of the salts of chromium." In it the author states that the salts of chromoxyd modified by boiling (green modification) are insoluble in ammonia except after having been boiled in acid and precipitated by ammonia. It will be observed that the above process is not in conformity with the opinion of M. Frémy, as it is there shown that the green modification, produced by boiling, is rendered soluble in ammonia *by the simple addition of sulphuric acid* and without any application of heat. The solution in ammonia is always complete, and the process never fails.

precipitation of chromoxyd. On cooling, picrate of ammonia crystallizes out. Even with very careful washing the salt is always partly decomposed, with separation of green oxyd of chromium.

The portions that were least decomposed were selected, but were not sufficiently pure to give any satisfactory result, although a number of specimens were analyzed.

1.	·6949	substance gave	·5864	picric acid.
2.	·5537	" "	·4735	" "
3.	·4446	" "	.3709	" "
4.	·4446	" "	·0179	sesq. ox. chromium.
5.	·6949	" "	·0271	" "

These numbers correspond to

1.	$C_{12}H_2N_3O_{14}$	84·02 per cent.
2.	"	85·14 " "
3.	"	83·06 " "
4.	Cr	2·78 " "
5.	"	2·63 " "

results which do not lead to any satisfactory conclusion, but show that the quantity of ammonia salt necessary to keep the chromoxyd in solution, throws down picrate of ammonia simultaneously with the ammonia-picrate of chromium. This salt is very beautiful, its lustre is remarkable.

Ammonia-picrate of Manganese.

If ammonia be added to a solution of manganous sulphate, previously rendered strongly acid with chlorhydric or nitric acid, a considerable quantity of manganese escapes precipitation, an extremely unstable solution is obtained, which in a few minutes, even before filtration is ended, becomes cloudy again. To give the solution more stability, the presence of a very large quantity of ammonia salt is necessary, a circumstance very unfavorable for the production of a pure ammonia-picrate, as by a solution so strongly saline, picrate of ammonia (as already observed) is at once precipitated. The following were the observations made:—

A. If a cold solution of picrate of ammonia be poured into an ammoniacal solution of manganese prepared by adding to a concentrated solution of manganous sulphate an equal volume of dilute chlorhydric acid, and then ammonia in large excess, there falls a precipitate of brilliant satiny scales, mixed however with precipitated manganous oxyd, which is readily distinguishable on the filter.

B. If the ammoniacal solution is added to a hot moderately strong solution of picrate of ammonia and the whole be rapidly

filtered, the liquid passes through before complete precipitation takes place, and on cooling, granular crystals are obtained which rapidly turn brown in the air. Heated on platinum foil, they turn brown, melt and deflagrate sharply with a brilliant white light.

Neither A, nor B, yield a salt sufficiently pure for analysis. A, always contains admixed manganous oxyd and B, picrate of ammonia. A, bears considerable resemblance to the chrome salt just described.

1·0115 of B gave ·9115 picric acid.

So large a percentage of picric acid corresponding to 89·72 per cent of the molecule $C_{12}H_2N_3O_{14}$ probably indicates a large admixture of picrate of ammonia, which cannot be removed. The formula

$$NH_3MnO.C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O \text{ requires 84·59 per cent.}$$

Ammonia-picrate of Iron.

An ammonia-picrate of protoxyd of iron appears to exist. If solution of protosulphate of iron be mixed with one of salammoniac, and then with liquid ammonia, be rapidly filtered, and the filtrate be treated with picrate of ammonia, a dark green crystalline precipitate is obtained: thrown upon a filter a red liquid passes through containing a portion of the picrate of ammonia reduced by the ferrous oxyd. The precipitate, when heated on platinum foil, deflagrates with scintillations. Heated with solution of salammoniac and caustic ammonia, it does not appear to dissolve, but ferric oxyd is thrown down and picrate and picramate of ammonia remain in solution. It was found impossible to obtain this salt in a condition to admit of even an approximate determination of its constitution.

If acetate of lead be treated with ammonia in excess, and if to the clear solution be added picrate of ammonia, a curdy precipitate, at first pale yellow, gradually deepening to orange color falls. Heated on platinum foil it detonates with violence. Boiled with caustic alkali, it disengages no ammonia. The result of an analysis showed it to be Marchand's penta-basic picrate of lead, $4PbO\ PbO\ C_{12}\left.\begin{matrix}H_2\\3NO_4\end{matrix}\right\}O$. The above described salts containing ammonia are all highly crystalline. The lead compound just mentioned is amorphous.

Other ammonia picrates exist which I propose to examine hereafter.

Philadelphia, July 14, 1860

ART. XI.—*The Guernsey County (Ohio) Meteorites,—a complete account of the phenomena attending their fall with a chemical analysis of them;* by J. LAWRENCE SMITH, M.D., Prof. of Chemistry in the University of Louisville, Ky.

AGREEABLY to the promise made in the July number of this Journal, I propose giving, as far as possible, a complete account of the remarkable fall of meteoric stones that occurred in the month of May in the eastern part of the State of Ohio.

I have thought proper to call them the *Guernsey County Meteorites;* since we are commonly in the habit of distinguishing the meteorites found in this country, by the name of the county in which they fell or were found. All but one of the great number of meteoric stones that fell on this occasion, were found in Guernsey county and that exceptional specimen fell in Muskingum on the edge of Guernsey county.

Although the public have been notified of this phenomenon by various observers, especially by those who gave their observations in the July number of this Journal; yet, as this paper was nearly completed at the time, and is believed to embrace a full description, it is as well to present it to the public as it is; combining all the particulars of this fall of meteorites, the most remarkable ever observed in this country, and equal to, if not surpassing the famous fall at l'Aigle in France, with which it has many points of interest in common, that will be stated in the course of this paper.

My attention was first directed to this occurrence, by a short notice of it in a newspaper, as being an earthquake that had occurred in eastern Ohio, accompanied with a shower of stones Suspecting the true nature of the phenomenon, I immediately visited the spot, where it was said to have occurred and collected the statements of those persons who had witnessed the fall. It was ascertained that on Tuesday, May 1st, 1860, remarkable phenomena transpired in the heavens, of which the following are accounts given by different observers, men of intelligence and observation.

Mr. McClenahan states that at Cambridge in Guernsey county Ohio, (lat. 40° 4′ long. 81° 35′) about twenty minutes before one o'clock, P. M., three or four distinct explosions were heard, like the firing of heavy cannon, with an interval of a second or two between each report. This was followed by sounds like the firing of musketry, in quick succession, which ended with a rumbling noise like distant thunder, except that it continued with about the same degree of intensity until it ceased. It continued two or three minutes and seemed to come from the southwest, at an elevation above the horizon of 30 to 40 degrees, terminating in the

southeast, at about the same elevation. In the district where the meteorites fell, the explosions were heard immediately overhead.

The first reports were so heavy as to produce a tremulous motion, like heavy thunder, causing the glass in windows to rattle. The sound was so singular, that it caused some excitement and alarm, many supposing it an earthquake. At Barnesville, twenty miles east of Cambridge, the cry of fire was made, as the rumbling sound was thought to be the roaring of fire.

The day was cool and the sky covered at the time with light clouds. No thunder or lightning had been noticed that day; nor could any thing unusual be seen in the appearance of the clouds. Immediately on hearing the report, this observer looked in the direction it came, and noticed the clouds closely but could not see any thing unusual.

The next morning it was reported in Cambridge that aerolites had fallen on a farm in the vicinity of New Concord, (eight miles east, a little south of Cambridge), enquiries were immediately instituted, and Messrs. Noble and Hines state that they were near the house of a Mr. Amspoker at the time of the first explosion, which seemed directly over their heads. They looked up and saw two objects, apparently come through the clouds producing a twirling in the vapor of the cloud at the point, where they came through, then descending with great velocity and a whizzing sound to the earth—one striking about 300 yards to the southwest of them and the other about 100 yards north.

They immediately went to the spot where the first fell, and found it buried two feet in the ground. They dug it out and found it quite warm and of a sulphurous smell. The other struck a fence corner and breaking the ends of some of the rails penetrated into the earth sixteen or eighteen inches, passing through a heap of dry leaves; the first weighed 52 ℔s., the other was broken up but must have weighed about 40 ℔s. Another of 41 ℔s. weight, not seen to fall, was discovered at the bottom of a hole two feet deep, where it had fallen on stiff turf, and was seen at the bottom of the hole, having carried the sod before it. It must have come from the southeast at an angle of 60° with the horizon. Many were discovered to have fallen southeast of Cambridge but of smaller dimensions than those already referred to. At the time of the occurrence nearly all were at dinner, or in and about their houses. The stones obtained were mostly found near houses, where they were seen to fall, as the sound of their striking the ground attracted attention.

Another well informed observer, Dr. McConnel of New Concord, (a small town eight miles east of Cambridge), furnishes the following particulars. On Tuesday, the 1st of May, at twenty-eight minutes past twelve o'clock, the people of that vicinity

were almost panic stricken by a strange and terrible report in the heavens, which shook the houses for many miles distant. The first report was immediately overhead, and after an interval of a few seconds, was followed by similar reports, with such increasing rapidity, that after the number of twenty-two were counted, they were no longer distinct, but became continuous and died away like the roaring of distant thunder; the course of the reports being from the meridian to the southeast. In one instance, three men working in a field,—their self possession being measurably restored from the shock of the more terrible report from above,—had their attention attracted by a buzzing noise overhead and soon observed a large body descending, strike the earth at a distance of about one hundred yards. Repairing thither they found a newly made hole in the ground, from which they extracted an irregular quadrangular stone weighing fifty-one pounds. This stone had buried itself two feet beneath the surface and when obtained was quite warm.

To this we add the following statement: "We the undersigned do hereby certify; that at about half past twelve o'clock on Tuesday, May the 1st, 1860, a most terrible report was heard immediately overhead, filling the neighborhood with awe. After an interval of a few seconds a series of successive reports, the most wonderful and unearthly ever before heard by us took place, taking a direction from meridian to southeast, where the sounds died away like the roaring of distant thunder, jarring the houses for many miles distant."

Signed by A. G. Gault, Jas. McDonnald, Nancy Mills, Ichabod Grumman, Samuel Harper, Rev. Jas. C. Murch, Mrs. M. Speer, Ang'e McKinney.

The above is from those who heard the noises but did not see the fall; the following are a few statements of the many I collected from those who witnessed the fall of the stones. I extract from their depositions made at the time.

"I heard the reports and roaring as above described. And a few seconds afterwards, I saw a large body or substance descending and strike the earth four or five hundred yards from where I then stood: and that I in company with Andrew Lister, repaired to the spot and about eighteen inches beneath the surface found a stone weighing fifty pounds." Signed by Samuel Reblu.

"Heard the reports and roaring as above described: and the said Mrs. Fillis further says, that a few seconds afterwards she heard a descending buzzing noise as of a body falling to the ground. And Miss Cherry also says that she was standing near Mrs. Fillis, heard the same and saw some substance descend and strike the earth some one hundred yards distant and that Mrs. Fillis repaired to the spot and there found a stone eighteen inches

beneath the surface weighing twenty-three pounds." Signed by Agnes Fillis, Mary J. Cherry.

"I distinctly heard the roaring and sounds as above described and a few seconds after the above report, I saw descending from the clouds a large body that struck the earth about one hundred and fifty yards from where I then stood, and I immediately repaired to the spot and about two feet beneath the surface found a stone weighing forty-two pounds, a second or two after seeing the first stone, I saw another descend and strike the earth about the same distance from where I stood, I also took the last mentioned stone from the earth about two feet beneath the surface; both the above stones when taken from the earth were quite warm. I also saw a third stone descend." Signed by Samuel M. Noble.

One observer saw a stone fall within three feet of his horse's head. One of the most southerly stones struck a barn; while some people retired within doors for fear of being struck.

These, with many others of a similar nature, were the data obtained near the region of the fall of stones. It is important to remember, that to these near observers no luminosity or fire ball was visible.

In addition to the above facts collected by ourselves, we have the following from observers at more distant points as already published by Profs. Andrews and Evans.

From the data they have collected, they consider the area over which the explosion was heard, as probably not less than one hundred and fifty miles in diameter. "At Marietta, Ohio, the sound came from a point north or a little east of north. The direction of the sound varied with the locality. An examination of all the different directions leads to the conclusion that the central point from which the sound emanated, was near the southern part of Noble county, Ohio," its course being "over the eastern end of Washington county, then across the interior of Noble county, then over the southwestern corner of Guernsey and the northeastern corner of Muskingum, with a direction of about 42° west of north."

"Mr. D. Mackley of Jackson county states that he was standing on the platform at the railroad station in Berlin, 20 miles south of Parkersburg, when he saw in a northeast direction, a ball of fire about 30° above the horizon. It was flying in a northerly direction with great velocity. It appeared as white as melted iron, and left a bright streak of fire behind it, which soon faded into a white vapor. This remained more than a minute, when it became crooked and disappeared."

Mr. Wm. C. Welles of Parkersburg, Virginia, (lat 39° 10′, long. 81° 24′,) about sixty miles south of Cambridge, saw the meteorite as a ball of fire of great brilliancy emerging from be-

hind one cloud and disappearing behind another. Other observers at some distance to the south of the point where the fall occurred saw this meteorite as a luminous body.

The above I conceive to be all the observations worthy of note concerning the fall of this meteorite.

The time of the day, and the number and intelligence of the observers, unite to give considerable interest and value to these observations. While some of them show points of difference, natural to the observation of sudden and startling phenomena, we can yet deduce from them many conclusions with more or less accuracy, thus:—

The direction of the Meteorite.—My own observations of two of the stones which fell half a mile apart, enable me to give the direction of the meteor with some degree of exactness. The first of these stones struck the end of the rails of a Virginia (zig-zag) fence, half way down, just touching the middle rail, breaking off more and more of each rail as it passed to the ground. Connecting the points of fracture by a line, this line represents a descending curve from S.E. to N.W.

Again, the stone that fell at Law's (the most northerly), struck a large dead tree laying on the side of a hill, sloping N.W., passing through it as any projectile would; it then struck a small clump of elders, breaking them off at the root, falling finally at the foot of the hill. A line connecting these points shows the curve already stated. Coupling with this the observation of Mr. Callahan, on the direction that one of these stones penetrated the ground, with the observed path of their distribution, no doubt can remain that the general direction of their fall was from S.E. to N.W., striking the ground at an angle of about 60°.

Altitude of the Meteorite.—This is a point that can be determined but very imperfectly if at all. It may have been when first seen 40 miles above the earth, but when the explosion was heard it must have been nearer and was even still nearer when it subdivided and was scattered ('exploded' as usually termed,) over Guernsey and the edge of Muskingum counties. It is, however, but proper that I should give Prof. Evans's computation from the data he collected; they were published in the July number of this Journal, but their reproduction will not be out of place here.

"Mr. William C. Welles of Parkersburg, Virginia (lat. 39° 10′, long. 81° 24′), a gentleman of liberal education, testifies that being about three miles east of that place at the time of the occurrence, he happened to look up to the northeast of him, and saw a meteor of great size and brilliancy, emerging from behind one cloud and disappearing behind another. When about 35° east of north he thinks its altitude was 65°. Now the distance, in a direction 35° east of north, from his station to the line directly under the meteor's path, is 20 miles. Calculating from

these data I find for the vertical height, taken to the nearest unit, 43 miles. This was at a point in Washington county near the border of Noble.

"Mr. C. Hackley testifies that he saw the meteor from Berlin in Jackson county. It crossed a cloudless space in the northeast, and he thinks its altitude, at the highest point, was 30°. Now the distance from Berlin to the nearest point under the meteor's path is 70 miles. These data give nearly 41 miles for its vertical height over Noble county, a few miles to the south of Sarahsville (lat. 39° 53′, long. 81° 40′).

"Many other reliable witnesses have been found who saw the meteor through openings in the clouds from various points west of its path; and whose testimony so far agrees with the foregoing as to give results ranging between 37 and 44 miles. Care has been taken as far as possible to verify the data in each case by personal examintion of the witnesses. The angles have in most instances been taken as pointed out by them from their respective posts of observation. It is unfortunate that no case has come to our knowledge in which the meteor was seen from the region east of its path. But it was a circumstance in some respects favorable to the definiteness of the observations made from the west side, that the observers in nearly all cases saw the meteor only at one point, or within a very small space on the heavens. It is impossible to reconcile the various accounts without granting that its path was very nearly as above described, and that its height did not vary far from 40 miles as it crossed Noble county.

"In regard to the time which intervened, at different places, between seeing the fire-ball and hearing the report, the statements are so vague that not much reliance has been placed upon them. It may be remarked, however, that they will essentially agree with the foregoing conclusions, if we suppose that the loudest explosion took place in the southern part of Noble county.

"I will add under this head the statement of Mr. Joel Richardson, of Warren, Washington county, who from a place six miles west of Marietta, saw the meteor as much as 15° or 20° west of north, at an altitude of about 45°. The direction in this case was so oblique to the meteor's path, that the data are of little value for simply determining the height; but they are important on account of their connection with the place of the meteor's last appearance. Mr. Richardson was visited by the writer, and his testimony was subjected to close scrutiny. If we take the azimuth at 15° west of north, we shall have a distance of 41 miles to the line under the meteor's path; and these data will give about 41 miles for its vertical height over a point not more than a mile from New Concord, at the extreme western limit of the district along which the meteorites were scattered. If we take the azimuth at 20° west of north, both the distance and the

height will be greatly augmented. I have found two persons living near Bear Creek, nine miles north of Marietta, who make statements closely corroborating that of Mr. Richardson.

"D. Mackley, Esq., a lawyer of Jackson, Ohio, who at the time of the occurrence happened to be at Berlin, about six miles northeast from the former place, and seventy miles from the nearest point under the meteor's path. He took pains to note all the facts as accurately as he could at that time; and he afterwards returned to the spot in order to determine more definitely the points of the compass. His testimony, in answer to my interrogatories is substantially as follows:—

"The meteor first appeared to me at a point about 55° east of north. It moved northward in a line very nearly parallel with the horizon. When it disappeared it had described an arc of about 15°. It was in sight about 6 seconds. Its altitude was about 30°. In regard to its size, I have since looked at the sun through a thin cloud, and I think the apparent diameter of the meteor was one-half that of the sun."

"These data give the meteor a height of 41 miles over the northern boundary of Noble county; a diameter of three-eighths of a mile; and a relative velocity of nearly four miles a second. The results agree sufficiently well with those before given."

Temperature of the Stones.—Several of the largest stones were picked up ten minutes after their fall, and are described as being about as warm as a stone that had lain in the sun in summer. One fell among dry leaves that covered it after it had penetrated the ground; the leaves, however, showed no evidence of having been heated; no appearance of ignition was discovered in places or objects with which the stones came in contact at the time of their fall, so that their temperature must have fallen far short of redness, while it may not have reached that of 200°.

Size and Velocity.—I have no data upon which to calculate either of these. Prof. Evans, however, as just quoted, calculates from the data above given, that its size was $\frac{3}{8}$ of a mile and velocity four miles a second.

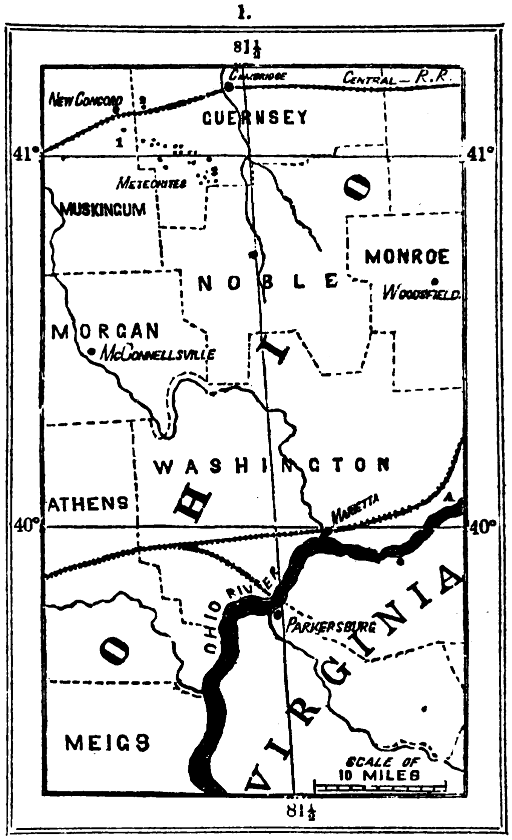
While I may furnish no more reliable computations from the data obtained, I may be excused a short criticism on the above results to prevent too hasty conclusions being formed.

As regards the supposed elevation of forty miles *when the first reports were heard*, I would simply ask the question, is it possible, with the established views of the conduction of sound by rarefied air that any conceivable noise produced by a meteorite forty miles distant from the earth, in a medium quite as rare if not rarer than the best air pump can produce, would reach us at all, or if so, in the manner described by observers? This question is a more important one to consider, as some observers on similar data have calculated the elevation of meteorites, where they were first heard to explode, at one hundred miles.

As regards the size of the meteorite, I have but to refer the reader to my experiments made in 1854, and published in this Journal in 1855,* to show the perfect fallacy of calculating the size of luminous objects by their apparent disks, and I shall have more to say on the same subject in a future paper. It is important to note that the nearest approach of the meteor to the earth must have been in the northern part of Noble and in Guernsey counties, the point from which its most wonderful display seemed to have manifested itself, yet we hear nothing of its future career by reports from observers north of this, while its approach from the south to this point was noticed by a number of observers.

I need hardly state my own convictions are, that the meteorite terminated its career in Guernsey county, and that the group of stones which constituted it were scattered broad cast over that county: many have been collected, and many lie buried in the soil to moulder and mingle their elements with those of this earth.

1.



We come now to consider the stones that fell and were collected. Their number was over thirty, and their places of falling have been plotted with some care in the accompanying map.

The localities of twenty-four have been fixed with precision, by the assistance of the Hon. C. J. Albright; but from the diminished scale of the map, it is impossible to place a number by each dot intended to represent the locality of a meteoric stone. No. 1 on the map is the spot where the largest stone was found, weighing 103 lbs. No. 2 is the next largest, weighing 56 lbs., and No. 3, the smallest, weighing 8 oz. The largest were at the northwest extremity, and smallest, at the southeast, the space over which they were scattered, was about ten miles long by three miles broad.

* Vol. xix, 340.

The following is a catalogue of 24:

No.	Weight.	Fell on farm of
1	103 lbs.	Shenholt.
2	56 "	Law.
3	52 "	Amspoker.
4	50 "	Amspoker.
5	41 "	Torrence.
6	36 "	Reasoner.
7	$23\frac{1}{2}$ "	Hodges.
8	26 "	Fillis.
9	16 "	Adair.
10	15 "	Craig.
11	$8\frac{1}{2}$ "	Craig.
12	$4\frac{1}{2}$ "	Waller.
13	4 "	Beresford.
14	$3\frac{3}{4}$ "	Craig.
15	$3\frac{3}{4}$ "	Stevens.
16	$3\frac{3}{4}$ "	Wall.
17	3 "	Walker.
18	$2\frac{3}{4}$ "	Claysville.
19	2 "	Stevens.
20	2 "	Wall.
21	2 "	Savely.
22	1 "	Carter.
23	1 "	Heskett.
24	$\frac{1}{2}$ "	Heskett.

Others have been found but I have no correct record of their exact position.

Some fifteen of these stones have come under my observation; they are all irregular in shape, cuboidal, wedge-shaped, globular and every conceivable form that irregular fragments of stone may be supposed to possess; they all have the well-known black coating with a sharp outline between the coating and grey mass of the stone, and there is quite a uniformity in the character of the coating in both small and large stones.

When broken this meteor exhibits a grey mass, with metallic particles of nickeliferous iron,* resembling the stones I examined that fell in Harrison county, Indiana, on the 28th of March, 1859, the latter however is the coarser grained of the two. Prof. Shepard who is familiar with the meteoric stones preserved in the cabinets of this country and in Europe, says: "In its internal aspect it approaches the stone of Iekaterinoslaw, Russia, (1825), though it is somewhat finer and more compact. In crust the two are identical. It is also similar to the stone Slobodka, Russia, (Aug. 10th, 1818); and compares closely with those of Politz, (Oct. 13th, 1819), of Nanjemoy, Maryland, (Feb. 10th, 1828),

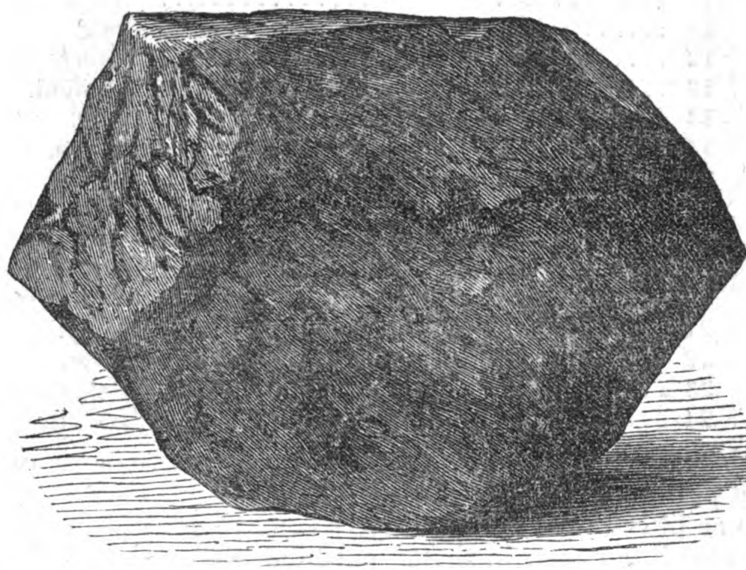
* I have picked out pieces of the iron weighing two grains, closely cemented to pyrites.

and of Kuleschowka, Russia, (March 12th, 1811), but the crust is less smooth on the Ohio stone than in that of the latter. In fact its character is, that of a large portion of the known meteoric stones."

The general thickness of the crust is about from $\frac{1}{30}$ to $\frac{1}{40}$ of an inch.

The following is the figure of the largest stone that has been found, now in the cabinet of Marietta College, and described by Prof. E. B. Andrews, (this Jour., July, 1860, page 104). We reproduce the figure from Prof. Andrews's article here cited.

2.



Several specimens have been examined, they all show the presence of the same minerals with a slight variation in their proportions as might be expected in a mass not homogeneous. Its composition is fairly represented as follows:—Specific gravity, 3·550, varying slightly in different specimens.*

In 100 parts, there are,—

Nickeliferous iron,	10·7
Earthy minerals,	89·3

The nickeliferous particles separated by a magnet from the crushed stone and well washed, presented the following constituents in 100 parts.

Iron,	87·011
Nickel,	12·360
Cobalt,	·421
Copper,	minute quantity not estimated.
Phosphorus,	·012
Sulphur,	1·080

* Mr. Johnson gives it as 3·5417, this Journal, [2], xxx, 111.

The sulphur comes from magnetic pyrites that the meteorite contains and that it is not easy to separate mechanically from the small particles of nickeliferous iron.

The earthy part when freed as thoroughly as possible from nickeliferous iron (which can be done pretty effectually by the magnet), was treated with warm dilute muriatic acid, thrown on a filter first washed thoroughly with water, then with a solution of potash to dissolve the last portion of the silica of the decomposed portion of the mineral. The result was in 100 parts:

Soluble portion,	63·7
Insoluble "	36·3

The earthy material analyzed as a whole was found to contain,

Silica,	47·30
Oxyd of iron,	28·03
Alumina,	0·31
Magnesia,	24·53
Lime,	·02
Soda, Potash,	1·04
Manganese,	*trace.*

From these results it is very clear that the mineralogical constitution of these meteoric stones is about as follows in 100 parts.

Nickeliferous iron,	10·690
Schreibersite,	·005
Magnetic pyrites,	·005
Olivine,	56·884
Pyroxene,	32·416

This sums up the history of this meteoric shower, with as full an account as possible of the stones that fell at that time. In the first part of this paper it was stated that this fall was quite as remarkable as that near L'Aigle in France in 1803. Although it does not equal this latter in the number of stones that were collected, it exceeds it in the size of the stones that fell. The largest of the L'Aigle stones weighed 17½ lbs., while the largest in the present case was 103 lbs.

There are many points of coincidence in the phenomena and circumstances attending the two falls. Were I to copy Biot's description of the phenomena of the fall at L'Aigle as detailed to the Academy of Sciences nearly sixty years ago, it would be but a repetition of what has been written in the first part of this paper.

The date of fall at L'Aigle was the 26th of April, the date of the Guernsey fall, May 1st; time of the day of the former, one o'clock, of the latter, twenty minutes of one. The direction of both falls from southeast to northwest. The extent of surface covered by the first seven and a half miles wide by two and a

half broad, by the latter, ten miles long by three wide. And both were seen by a large number of persons.

Since my memoir on meteorites was presented to the American Association for the Advancement of Science, and published, I have collected several important physical and chemical data that cannot be overlooked in the study of the nature and origin of these bodies. I will merely enumerate some of them now; reserving for a future occasion the proof upon which they are based and the deductions that may be drawn from them. 1st. The light emitted from meteoric stones does not arise from incandescence, but from electricity or some other cause. 2nd. That the noise attending their fall is not that arising from the explosion of a solid, but that it is by concussion of the atmosphere arising from the rapid motion of the body through it or in part due to electric discharge.

3d. That meteoric showers are not the results of fragments from the rupture of one solid body, but the separation of small and distinct aerolites that have entered our atmosphere in groups. 4th. That the black coating is not of atmospheric origin, but is already formed when these bodies enter our atmosphere.

I would also call the attention of those engaged in the examination of this class of bodies to the study of the true nature of their black coating, also to the fact that observers at a distance often see these bodies in a luminous state, while those situated where they fall, do not observe this luminosity.

ART. XII.—*Abstract of a Discussion of the Influence of the Moon on the Declination of the Magnetic Needle, from the observations at the Girard College, Philadelphia, between the years* 1840 *and* 1845; by A. D. BACHE, Superintendent United States Coast Survey.

THE existence of a sensible lunar effect on the magnetic declination has already been established by the labors of Brown, Kreil, Sabine and others. It is nevertheless important to add the weight of new numerical results to those already obtained.

In the discussion of the Philadelphia observations of magnetic declination already presented to the Association, I have shown how the influence of magnetic disturbances, of the eleven year period, of the solar diurnal variation and its annual inequality, of the secular change, and of the annual variation may be severally eliminated, leaving residuals from which the lunar influence is to be studied.

Each observation was marked with its corresponding lunar hour and the hourly normals used for comparison. This method

of treatment of the subject is that followed by General Sabine in his discussion of the results of the British observations. The details of the method will be better understood by an example.

The time of the moon's passage over the meridian of Philadelphia (upper transit) was obtained from the American Almanac, the small correction for the difference of longitude being neglected. The observation nearest to the local mean solar time of the moon's transit was marked with a zero, signifying 0^h of lunar time. The time of the inferior transit was next obtained, and the observation nearest to it in time was marked 12^h. The greatest difference in interval between the moon's transit and the time of observation could in no instance exceed half an hour. In the bi-hourly series the observations nearest the moon's transit, or to either hour angle, one hour before or one hour after the transit was marked. The mean of a number of differences for the same hours will thus give a result corresponding sufficiently near to the hour. The number of observations intermediate between those marked 0^h and 12^h were marked with the corresponding hour angle by interpolation, care being taken to note the nearest full hour against each observation in the bi-hourly series. The hourly series begins with October, 1843. In the case of thirteen observations within twelve lunar hours, the one nearest midway between the two consecutive lunar hours was omitted.

The month of March, 1842, is selected as an example of working the bi-hourly series, and the tables are given in the complete paper which, it is expected, will be published in the Smithsonian Contributions to Knowledge.

One of the first questions to be determined is, how many of these residuals must be used to give a definite result, another one is, whether numbers deduced from different parts of the series would give harmonious results. To test both of these the observations were formed into three groups, one containing 4900 in 19 months of 1840 and '41; another 6715 results in 21 months of 1842 and '43; and a third 10029 results in 18 months of 1844 and '45; in all 21644 results.

The tables for the several months and for each year, showing the residuals for each lunar hour, are given in the complete memoir in detail, as also the results of the discussion of groups I and II, and of III, in which all the observations are united. Special investigation showed that the weights were nearly proportional to the number of observations, a result which indicates that no undue constant errors influence the result.

The results of the discussions of these three groups were also expressed by Bessel's formula and treated by the method of least squares. Two terms of the formula suffice to represent the observations, and there is no constant term, indicating that

the moon has no specific constant action of deflection on the needle. The coefficient of the first term is small, the character of the curve depending chiefly upon the second term which produces a double crested curve showing two eastern and two western deflections in one lunar day. The difference in the amount of the eastern and of the western ranges depends upon the coefficient of the first term. The progression of the hourly values is systematic, and the agreement between the computed and observed values is satisfactory. On the Diagram B, the observed values are indicated by dots and the smooth curve results from the equation.

The difference between the curves of deflection for the eastern and western hour angles shown in the curve, enables us to determine the diurnal lunar tide and is drawn on the plate and represented by the first term of the formula. The interference of the two curves gives the observed form.

The curves all agree in their distinctive characters, and show two east and two west deflections in a lunar day, the maxima W. and E. occurring about the upper and lower culminations and the minima at the intermediate six hours. The total range hardly reaches 0′·5. These results agree generally with those obtained for Toronto and Prague. From 8000 to 10000 observations seem to be required to bring out the results satisfactorily, and the best results are derived from the use of both groups. The principal western maximum occurs six minutes after the lower culmination of the moon and amounts to 0′·23. The secondary maximum occurs fourteen minutes after the upper culmination and amounts to 0′·18. The principal maximum occurs at 6^h 17^m after the lower culmination, the easterly deflection being 0′·22. The secondary maximum at 6^h 03^m after the upper culmination has a deflection of 0″·19. The greatest range is 27″ and the secondary 22″. The epochs of the maxima and minima are found from the formulæ to be at a mean, ten minutes after culmination. The probable error of a single computed value of the lunar diurnal variation is ±1″·32. The Toronto observations gave ±1″·37 from more than twice the number of observations, so that the Philadelphia observations appear to be worthy of every confidence. At Toronto from the second investigation, embracing about 44,000 observations, the western and eastern deflections balanced, giving for the range 38″·3. The Prague observations also confirm the nearly equal deflections (mean) to the west and east. The epochs of the maxima and minima were found from the four roots of the equation $0=0{\cdot}029\cos(\theta+295^\circ)+0{\cdot}414\cos(2\theta+85^\circ)$ which gave ten minutes as the mean time elapsed between the moon's passing the meridian and the time of maxima of deflection. If we take the four phases into account the lunar action seems to be retarded ten minutes, which may be termed the *lunar*

magnetic interval for the Philadelphia station. At Toronto the intervals are not so regular. The secondary range exists there, and is also a marked feature in the Prague results.

The lunar diurnal variation seems to be the subject of an inequality depending on the solar year, for the investigation of which the preceding results were rearranged in two groups, one containing the hourly values for the summer months (April to September), the other the values for the winter months (October to March). For the summer season we have 11087 observations, and for the winter 10557.

In the complete memoir the tables of the hourly sums of the lunar variations for the summer and winter seasons are given, and the tabular results are expressed analytically. The curves representing them are shown in the annexed Diagram C.

The characteristic feature of the annual inequality in the lunar diurnal variation is, therefore, a much smaller amplitude in winter than in summer. Kreil indeed inferred from the ten year series of the Prague observations that in winter the lunar diurnal variation either disappears or is entirely concealed by irregular fluctuations, requiring a long series for their elimination. The method of reduction which he employed was however less perfect than that now used. The second characteristic of the irregularity consists in the earlier occurrence of the maxima and minima in winter than in summer. The winter curve precedes the summer curve by about one and three quarter hours. Both these features are well expressed in the diagram C. At Toronto the same shifting in the maxima and minima epochs was noticed, but the other irregularity in the amount of deflection is not exhibited. It seems probable that the Philadelphia results are more typical in form than those either of Prague or Toronto.

It is also apparent that the smaller deflection at the upper culmination in the annual mean, when compared with the deflection at the lower culmination, is entirely produced by the feeble lunar action in winter. The maximum west deflection in summer occurs actually near the upper culmination. At the same season the maximum east deflection is still retained (as in the annual curve) about six hours after the lower culmination. In the winter season this last mentioned maximum east deflection is actually the smaller of the two. We have

Maximum summer range, - - -	$35''\cdot4$,	secondary	$31''\cdot8$
" winter " - - - -	$25\ \cdot2$,	"	$15\ \cdot6$
difference, - - - -	$10\ \cdot2$,		$16\ \cdot2$

At Prague the maximum summer range was $44''$.

I next proceed to examine whether the phases, declination or parallax of the moon, have any sensible effect upon the magnetic declination. Dr. Kreil found from a ten years series

of observations at Prague, that there was no specific change in the position of the magnet depending upon the moon's phases and parallax, but that the declination was 6″·8 greater when the moon was at the greatest northern declination than when at the greatest southern declination. On the contrary Mr. Brown from the Makerstoun observations, a much shorter series than the one at Prague, inferred that there was a maximum of declination two days after the full moon. He also found a maximum corresponding to the greatest northern declination of the moon, but does not appear to have investigated the effect of distance.

The residuals which we have been treating enable us at once to examine these several points.

Beginning with the lunar phases, the daily means for the day of full and new moon, and for two succeeding days, were compared with the monthly mean declination. In case any of the hours were disturbed, the monthly normal for the hour was substituted for the disturbed observation before the mean was taken. If one half or more of the hourly readings were disturbed, the daily mean was altogether omitted. Accidental omissions of hourly observations were supplied by the hourly normal. The half monthly normals were then compared with the half monthly means. In the table of differences thus formed equal weight is given to the bi-hourly and hourly observations. The daily mean having been subtracted from the monthly mean, the positive sign indicates a western deflection and the negative sign an eastern one, as compared with the normal position. The following table contains the results :

	Sum of deflections.	Number.	Deflection.		
			d.		
Full moon,	+11·6	52	+0·22	+0′·10	±0′·07
1st day after,	− 7·1	51	−0·14	−0 ·06	
2d day after,	− 9·3	48	−0·19	−0 ·08	
New moon,	−11·5	43	−0·27	−0 ·12	±0′·09
1st day after,	+ 1·5	47	+0·03	+0 ·01	
2d day after,	+ 4·4	49	+0·09	+0 ·04	

The effect is very small, scarcely much beyond the probable error; but the table indicates that the north end of the magnet is deflected to the westward 0′·1 at the full and as much to the eastward at the day of new moon, the range between full and new moon being 0′·2. A more definite result could hardly be expected from a series of observations extending over but five years.

Treating the effect of the moon's variation in declination in precisely the same manner we obtain the following results :

Mean deflection.			
One day before,	−0′·20	from 54 days of observation.	
At moon's max. declin.,	−0′·10	" 53	"
One day after,	−0 ·09	" 55	"
Mean,	−0 ·13	" 162	"
One day before,	−0 ·04	" 54	"
At moon's min. declin.,	−0′·07	" 52	"
One day after,	+0 ·14	" 52	"
Mean,	+0 ·01	" 158	"

The results do not positively prove a deflection of the magnet depending on the moon's greatest north and south declination. The amount resulting from the comparisons being of nearly the same magnitude as its probable error.

A similar investigation with respect to the moon's distance from the earth gives the following results.

Mean deflection.			
One day before,	−0′·18	from 50 days of observation.	
At moon's perigee,	−0·18	" 41	"
One day after,	−0·00	" 59	"
Mean,	−0·12	150	
One day before,	−0′·02	" 55	"
At moon's apogee,	−0 ·20	" 53	"
One day after,	−0·13	" 47	"
Mean,	−0·12	" 155	"

The difference being of the same order of magnitude as the probable errors, no conclusion as to the effect of distance can be drawn from them.

I propose hereafter to extend the discussion of the moon's effect on the declination to the effect on the earth's magnetic force.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the Chemical Analysis of the Solar Atmosphere.*—Kirchhoff has communicated some further results of his remarkable investigations on the constitution of the solar atmosphere, a notice of which has already been given in this Journal. The author maintains that the sun has an ignited gaseous atmosphere which encloses a core of still higher temperature. If we could see the spectrum of this atmosphere, we should detect the bright lines which are characteristic of the metals existing in it, and should recognize the metals themselves from these. The more strongly luminous body of the sun does not however permit the spectrum of his atmosphere to appear. It inverts this spectrum so that instead of the

bright lines which the spectrum of the atmosphere alone would exhibit, dark ones make their appearance. We see therefore, only the negative image of the spectrum of the sun's atmosphere.

In order to study the solar spectrum with the requisite degree of accuracy, Kirchhoff procured from the workshop of Steinheil an apparatus consisting essentially of four large flint glass prisms and two telescopes.

With this apparatus the spectra are seen in a hitherto unattainable degree of distinctness and purity. It exhibits in the solar spectrum thousands of lines with such clearness that they are easily distinguished from each other. It is the author's intention to draw the whole spectrum as seen with his apparatus, and he has already done this for the portion which lies between Fraunhofer's lines D and F.

This apparatus exhibits the spectrum of an artificial source of light with the same distinctness as the solar spectrum, provided only that the intensity of the light is sufficient. A common gas flame in which a metallic compound evaporates, is usually not sufficiently luminous but an electric spark gives with the greatest distinctness the spectrum of the metal of which the electrodes consist. A large Ruhmkorff's induction coil yields electric sparks in such rapid succession that the spectrum can be observed as easily as that of the sun.

A very simple arrangement permits the comparison of the spectra of two sources of light. The rays of one of the sources may pass through the upper half of the vertical slit, while those of another pass through the lower half. When this is the case, one of the two spectra is seen immediately beneath the other, and it is easy to determine whether coincident lines occur in both.

In this manner the author satisfied himself that all the bright lines peculiar to iron correspond to dark lines in the solar spectrum. In the portion of the spectrum between D and F, about 70 particularly well-marked lines occur, resulting from the iron in the sun's atmosphere.

Iron is remarkable on account of the great number of distinct lines which it produces in the solar spectrum; magnesium is interesting because it produces the group of Fraunhofer's lines lying in the green denoted by Fraunhofer by *b*, and consisting of three very strong lines. Very distinct dark lines in the solar spectrum correspond to the bright lines produced by chromium and nickel, and we may therefore regard the presence of these substances in the sun's atmosphere as proved. Many other metals appear however to be wanting in the sun's atmosphere. Silver, copper, zinc, lead, aluminum, cobalt and antimony have extremely brilliant lines in their spectra; but no distinct dark lines in the solar spectrum correspond to these.

Many metallic compounds do not give in a gas flame the spectrum of their metal, because they are not sufficiently volatile: in these cases the spectrum may be made to appear by means of the electric spark. It is true that in this case the spectrum of the metal of which the electrodes consist and that of the air in which the spark passes is also seen. To avoid the difficulty arising from the very great number of bright lines of which the spectrum of every electric spark consists, it is necessary to have recourse to a particular arrangement. The electric spark is allowed to pass at the same time between two similar pairs of elec-

tro'es, the light of one spark being allowed to pass through the upper, that of the other through the lower half of the slit, so that one spectrum is seen above the other. When the two pairs of electrodes are clean, the two spectra are perfectly similar: when however a metallic compound is placed upon one pair, the corresponding spectrum immediately shows the lines belonging to the metal introduced. The author has satisfied himself that in this manner even the metals of the rare earths, yttrium, erbium, terbium, etc., may be recognized most quickly and certainly. It is therefore to be expected that by the help of Ruhmkorff's apparatus, the spectral method of analysis may be extended to the detection of all metals. The researches which the author has undertaken in connection with Bunsen will, it is hoped, determine this point.—*Journal für prakt. Chemie, No.* 16, 1860.

2. *On a New Alkaline Metal.*—Bunsen has discovered in the waters of several mineral springs, a new alkaline metal, the existence of which was first detected by the spectral method of qualitative analysis, already noticed in this Journal. The new alkali exists in these waters together with potassium, sodium, and lithium, and its presence may be shown by the spectral analysis with the greatest facility, although only a few milligrammes are contained in several kilogrammes of the material. The author gives only a very brief preliminary notice of the new metal, promising a more extended investigation. The chlorid may be distinguished from the chlorids of sodium and lithium by the yellow precipitate which it gives with chlorid of platinum. It is distinguished from potassium by the solubility of its nitrate in alcohol. The vapors of the compounds of this metal, when heated so as to become luminous, give an extremely characteristic spectrum, which at the same time exhibits the remarkable simplicity of the spectra of the other alkaline metals. Its spectrum consists of only two blue lines—a weaker line, corresponding with the blue strontium line and another which lies only a little farther toward the blue end of the spectrum, and which vies in intensity and sharpness of definition, with the red line of lithium.—*Journal für prakt. Chemie,* 16, 1860.

3. *On the colors of Flames.*—Merz has communicated some investigations on the coloration of the flames of Bunsen's burner and of hydrogen gas produced by the presence of various substances. These observations may be considered as supplementary to those of Bunsen already noticed in this Journal, and although less certain, are simpler and more easily applied than the processes of the spectral analysis. The author employs a flame of pure hydrogen as well as that of Bunsen's burner, and in addition, makes use of blue, violet, red and green glasses. The new substances which he describes as giving characteristic colors to the flame of Bunsen's burner, are nitric, chromic and molybdic acids, while phosphoric and sulphuric acids give a peculiar coloration to the dark core of the flame of hydrogen.

The flame of Bunsen's burner gives three sorts of colors—*a.* Border colors. These are of course peculiar only to the most volatile substances. To produce them, the loop of platinum wire is to be held outside of the flame about one or two millimeters from the lower portion of the outer limit *b.* Mantle colors—those namely which are seen when the substance

is held in the bright blue colored mantle which forms the outer portion of the flame. *c.* Flame colors. To produce these, the loop is to be held horizontally and in the hottest part of the mantle. The hydrogen flame yields another species of color—viz, the core colors. These are produced only by sulphuric and phosphoric acids, which communicate respectively a blue and green tinge to the cold core of the hydrogen flame.

Nitric and nitrous acids give a bronze green border color, usually with an orange colored border. The test is to be previously dried in the flame, and dipped into a solution of bi-sulphate of potash, or into dilute muriatic acid, according as we wish to test for nitric or nitrous acid. The sensibility is about $\frac{1}{40}$ mgrm. Compounds of ammonia and cyanogen give the same bronze green border, but more faintly.

Phosphoric acid gives a grey-yellow-green border color, as well as a beautiful green core color. The dry test is to be dipped into sulphuric acid and held in the flame in the manner above pointed out, in order to show the border color. The sensitiveness is $\frac{1}{8000}$ mgrm. The green core color is less sensitive, but indispensable in recognizing phosphoric acid in the presence of large quantities of boric acid, and is produced by alternately moistening the test with a solution of fluosilicic acid, and holding it till ignition in the hydrogen flame, until the color distinctly appears.

Sulphuric acid produces a beautiful blue core color, being reduced to sulphurous acid. Free sulphuric acid gives the color when the platinum loop is held in the border of the flame, but a sulphate must be held in the middle of the flame. In the latter case, it is well to dip the test into strong muriatic or fluo-silicic acid. The sensibility for sulphuric acid is $\frac{1}{4000}$ mgrm., for a sulphate, $\frac{1}{1000}$ mgrm.

Boric acid gives a beautiful green mantle color, which is so intense that the acid may be recognized in the presence of large quantities of phosphoric acid. The sensibility $\frac{1}{1400}$ mgrm. Borates are to be decomposed with sulphuric acid.

Chromic acid gives a dark brownish red border color, and a rose red mantle color. The sensibility is $\frac{1}{1000}$ mgrm. The dry test is to be moistened with concentrated sulphuric acid, and held in the border. Oxyd of chromium gives no color, and is to be first oxydized to chromic acid by moistening with a solution of hypochlorite of soda, and drying. Molybdic acid gives a yellowish green flame-color like that of baryta, which is however very fleeting, and only occurs on moistening the test with muriatic acid.

Muriatic acid gives a very weak greenish blue border-color, which lasts for a very short time, and therefore does not deserve attention. The acid is however decomposed into free chlorine which may easily be recognized.

Potash gives a grey blue mantle-color and a rose violet flame color. These colors appear reddish violet through the blue glass, violet through a violet glass, and blue green through a green glass. Potash is recognized in the presence of lithia, as well as through so thick a layer of blue glass that the lithium red is no longer visible. The test is to be moistened with sulphuric acid, and repeatedly exposed to the flame for a short time. The sensibility is $\frac{1}{31.000}$ mgrm., for blue, $\frac{1}{15.000}$ mgrm. for green glass.

Soda gives an orange yellow flame-color, which in very large quantities appears pure blue, but in small quantities is invisible through the blue

glass; through the green glass, the soda flame appears orange yellow, even with the smallest quantities. This glass is particularly adapted to the recognition of soda in all its compounds. The sensibility is $\frac{1}{280.000}$ mgrm. The test is to be moistened with sulphuric acid; dried and held in the hottest point of the flame.

Lithia gives a carmine red flame-color which appears violet red through the blue, carmine red through the violet but is invisible through the green glass. The test is to be moistened with sulphuric acid and treated like potash, the sensibility is $\frac{1}{140.000}$ mgrm. In the presence of soda, lithia is recognized through the blue glass; in the presence of potash, by the method given by Bunsen. In the case of the alkaline earths, the test is to be moistened with sulphuric acid, carefully dried, and held in the hottest point of the mantle. After all the alkalies have evaporated, the earths may be detected.

Baryta may be recognized by the yellowish green flame-color which appears blue green through the green glass. The sensibility for baryta alone is $\frac{1}{8500}$ mgrm. If the green disappears and a red flame-color makes its appearance, the test is to be repeatedly moistened with muriatic acid, and immediately introduced while wet into the hottest part of the flame. If the blue green color is no longer seen, we proceed to examine for lime.

Lime is present when the red flame-color, on evaporating the last portion of muriatic acid, appears siskin green through the green glass. Strontia gives in this case a weak yellow. The sensibility of lime alone is $\frac{1}{7000}$ mgrm., but by employing the green glass, $\frac{1}{18.000}$ mgrm.

Strontia may be recognized by the purple or rose color which is seen through the blue glass when the test, after moistening with muriatic acid, is evaporated to dryness in the flame.

Copper as chlorid gives an azure blue zone, and as nitrate, a pure green flame-color. By the combined observation of both colors, copper may be distinguished from all other metals which give similar colors. The sensibility of copper alone is $\frac{1}{3.000}$ mgrm. The other flame-coloring metals, such as arsenic, antimony, tin, lead, mercury and zinc, exhibit especially in the form of chlorids, more or less intense bluish or greenish mantle-colors, which however cannot be advantageously used as reactions for the metals themselves.—*Journal für prakt. Chemie*, No. 16, 1860.

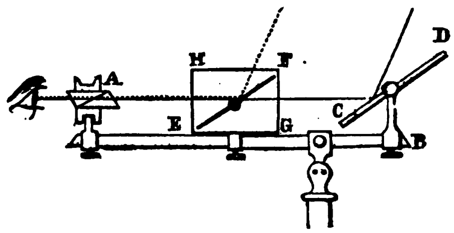
4. *The Dichroscope.*—The apparatus to which Prof. Dove has given this name is intended for the following purposes:—

(1.) To represent interferences, and spectra in different-colored light, both separately and combined.

(2.) To imitate the phenomena of dichroism, both in the case in which dichroitic crystals are viewed through Haidinger's rhomb of calc spar, and also in the case of the phenomena produced when the dichroitic crystals themselves are used as analyzers in a polariscope.

(3.) To combine elliptically, circularly, and rectilinearly polarized and unpolarized light, not in such a manner that the one is produced by the polarizing, and the other by the analyzing arrangement, but so that they traverse the doubly refracting media simultaneously, and are then submitted to any analyzing arrangement.

HEGF is the dichroscope which is placed in a polariscope as indicated in the figure; A, being the Nicol's prism, and CD the polarizing mirror.



It is a brass box 81 millim. long, 75 high, and 70 broad, three sides of which are open; these sides, HE, HF, FG, can be closed by opaque slides, or by plates of colored glass; a single glass plate, or sets of glass plates, can also be inserted in the direction EF, as seen in the figure. The side HE, is destined to receive cooled glasses, crystals, or a rotating circular-polarizing plate of mica. The side HE, can be closed by a slide having in it a slit for prismatic analysis or a circular aperture for experiments, with fine gratings. Two mirrors belong to the apparatus: one is silvered, the other blackened.

It being assumed that the linear analyzing arrangement is so placed that in a crystal of calc spar cut at right angles to its axis and placed between A and HE, the rings and black cross are visible, the following com inations may be obtained.

1st. Employing CD the silvered mirror and EF the glass plate: ordinary light reaches the analyzing prism from CD and linear polarized light from EF.

(*a.*) FG closed by an opaque slide: white linear-polarized light.

(*b.*) FG closed by the slide, in HF a colored glass: according to the nature of the glass, monochromatic or polychromatic linear-polarized light.

(*c.*) Colored glass at FG, HF open: unpolarized colored light and white linear-polarized light. The cross is seen brightly colored in the tint of the glass.

(*d.*) A colored glass at HF, FG open: colored polarized light with unpolarized white light. The rings become almost invisible.

(*e.*) Differently colored glasses at HF and FG. The rings appear as if the analyzing prism had been turned 90°; the cross is colored and the rings appear in the tints of the two glasses.

(*f.*) If a rotating mica plate be placed at HE the corresponding combinations of circular and elliptical, with unpolarized light are obtained.

2d. The silvered mirror CD is replaced by the blackened polarizing mirror. Two beams of light linearly polarized in the same plane, or if the mica plate at HE is used, circularly or elliptically polarized, reach the Nicol's prism.

They are (*a*), both white or both colored, (*b*) white and colored, (*c*) differently colored, according to the arrangements made.

3d. Between the mirror CD and the plate of glass EF, the mica plate is inserted: in this manner combinations of circularly or elliptically polarized light, with linear polarized light are obtained.

4th. The silvered mirror is placed at CD and a set of six glass plates is inserted at EF. This is so arranged that the light entering from CD and polarized by refraction in passing through EF is equal in intensity to the light polarized by reflexion at EF: the two beams are of course polarized

at right angles to each other; no figure is formed by the crystal of calc spar—the light is unpolarized.

Interesting experiments may be be made by weakening the intensity of either of these beams of light. If now colored glasses are placed in HF and FG the phenomena of dichroitic crystals may be obtained, as follows:—

(*a.*) The calc spar crystal is removed, and the Nicol's prism exchanged for a doubly refracting rhomb of calc spar. When a round aperture is inserted at HE, two images of it are obtained in different colors; by rotating the rhomb the tints pass into one another.

Crystals improperly termed dichroitic are now represented by using plates of glass of the same color, and weakening the intensity of one of the beams of light.

(*b.*) If a crystal of calc spar cut at right angles to its axis is inserted between A and HE the phenomena are obtained which dichroitic crystals exhibit when they are used in a polarizing apparatus as an analyzing arrangement.

By the intermixture of certain spectra Prof. Dove obtained colors which could not have been expected from the components, but which corresponded to the investigations of Wünch and Helmholtz.

Prof. Dove remarks that his dichroscope can with some inconvenience be adapted to the Nörremberg polariscope.

The little polariscope figured on page 536 (or 388, 2d edition) of Silliman's Nat. Phil. is however admirably adapted to its reception as I have ascertained experimentally.—*L. and E. Phil. Mag., No.* 134, *Nov.*, p. 352.

O. N. R.

5. *Dove's 'Optical Studies.'* *—(1.) Prof. Dove found in 1851, that by combining black and white surfaces in the stereoscope metallic lustre was produced, and upon this and similar experiments founded a theory of lustre. In his Optische Studien he describes a method of producing lustre without stereoscopic combination. A pattern cut out of red paper is pasted on a sheet of green paper or the reverse arrangement may be adopted. If a plate of red glass is held before one eye and one of green before the other, the picture is seen brilliant and lustrous as though painted on glass or porcelain. A blue figure on a red field, or the reverse, when viewed through red and blue glasses give similar results.

The lustre is most striking when the drawing is viewed from above.

(2.) *On a method of mingling at will colors produced by absorption or interference.*—see Dichroscope, this Journal p. 108.

(3.) *On the influence of binocular vision upon the estimation of the distance of bodies seen by reflexion and refraction.*—The following is a striking experiment. A cube of clear glass 2 inches in diameter was placed upon a colored glass cube 1 inch in diameter. When viewed with both eyes from above, the colored glass appeared to be converted into a four sided prism of double the height. (A piece of glass 1 inch thick with two parallel sides, placed on a cork $\frac{1}{2}$ inch in diameter shows this very deceptive phenomenon quite well.) If print be viewed through a large rhomb of calc spar by both eyes it will be seen that the two images do

* Optische Studien, by Prof. H. W. Dove, Berlin, 1859.

not lie in the same plane. This effect is imitated by Prof. Dove in two printed stereographs—see Sept. No. this Journal, p. 304.

[If a printed page be magnified by a plane convex lens 3 inches in diameter $2\frac{1}{2}$ in focal length, and viewed by both eyes, it will be seen that the letters are raised in the centre of the field, so that it instead of appearing flat seems to be convex. A single projection of a pyramid placed under the centre of the lens gains relief, though the lines drawn from the base to the apex rise toward the observer in curves. The effect is due to the distortion produced by viewing the drawing through the opposite halves of the lens.

On the other hand if two perfectly similar printed pages be viewed through the lenticular stereoscope, attentive examination will show that the field is apparently concave: the lines rising in shallow tiers, above and below; this is of course a defect in the instrument, since it alters the relief in which the objects are seen, increasing or diminishing it according to their position in the field.

On this account it may perhaps be advisable even where the most natural relief is desired to place the cameras somewhat farther apart than the distance between the eyes. Sir David Brewster, in his work on the stereoscope, page 108, gives us to understand that Wheatstone's reflecting stereoscope is not a "real optical instrument" (!) because pieces of *looking-glass* are employed in it. Must we now strike Sir David's lenticular stereoscope from the catalogue of optical apparatus because *semi-lenses* are employed in it, which alter the natural relief, in which according to the same author it is so *essential* that objects should be viewed?]

(4) *An interesting article on the application of the Stereoscope to distinguish copies from fac-similies.*—When two pages printed from the same type are combined in the stereoscope the printing appears to lie in the same plane—(in the lenticular stereoscope to be evenly distributed over a shallow concave surface). In the most careful attempt by the printer to set up a page or a few lines alike, the words and letters will in the stereoscope be seen to lie in different planes.—(See the illustration on page 304, vol. xxx, this Journal.)

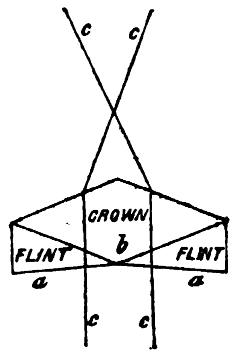
By this means when genuine and counterfeit bank notes are combined in the stereoscope the difference is at once detected. This is really a method of apparently converting distance in a horizontal, into depth in a vertical plane and greatly magnifying it.

(5.) *Upon the Electric Light,*—being an analysis of the weaker varieties of electric light by means of colored glasses. In passing from nearly invisible electric light to the electric spark, the changes are as though the spectrum was slowly uncovered by the withdrawal of a screen whose motion was in a direction from the violet toward the red. This makes it improbable that the increase of intensity in electric light is due to an increase of heat in the particles torn from the conductors. The action is more like that of the pale flame of hydrogen which becomes bright and white by the introduction of solid matter. O. N. R.

6. *Improvements in the Microscope.—Wenham's Improved Binocular Microscope.*—In the Quarterly Journal of Microscopical Science for July, 1860, Mr. Wenham has described an improved form of Binocular Microscope. The construction of this instrument will be understood from the

accompanying figures. The rays from the two sides of the object glass are transmitted through a compound achromatic prism shown in fig. 1, by which they are made to cross each other and diverge at an angle of 16°, so that at the distance of about eight inches the rays from the right side of the object enter the left eye, and the rays from the left side enter the right eye as shown in fig. 2.

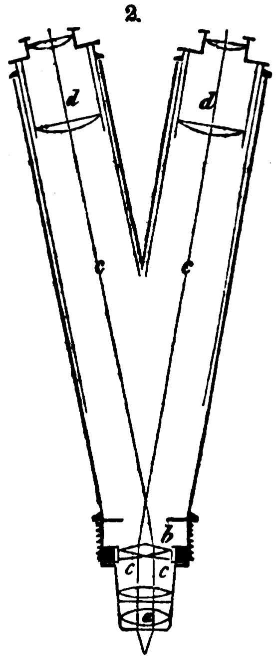
1.



Two prisms of flint glass *a a*, fig. 1, are cemented to a single four-sided prism *b* of crown glass; the angles of the prisms having such a relation to the refractive and dispersive powers of the two kinds of glass as to make the compound prism achromatic and give to the opposite pencils the proper convergence after leaving the prism. In an instrument of this kind, made under the direction of the writer, by Messrs. Grunow, the flint prisms have each a refracting angle of 26°, the lateral angles of the crown prism are 44°; the opposite faces of the crown prism are parallel; the refractive index of the flint glass is 1·621 and of the crown glass 1·534 and the dispersive powers of the flint and crown prisms are as 1·000 : 0·625.

In fig. 2, *a* represents the object-glass of the microscope, *b* is the compound prism, *c c*, *c c* show the position and direction of the two lateral pencils, and *d d* are two eye-pieces at the extremities of the two branches of the compound body and the microscope.

2.



Each branch of the compound body is furnished with a draw-tube which can be extended 2 or 3 inches if necessary. By this means the instrument can be adjusted to different eyes. When the draw-tubes are closed, the distance between the centres of the eye-pieces is 2 inches, and when drawn out two inches, the distance apart is 2½ inches. This is as great a range as is required to suit the eyes of most persons who wish to use the microscope.

A great superiority of this binocular microscope over other forms, as Nachet's and Riddell's, results from the extreme thinness of the achromatic prism. In both of the other forms named, the light twice suffers total reflection, and passes through a thickness of an inch or more of glass causing much aberration and loss of light. In the form described above there is little loss of light or aberration, as the greatest thickness of the achromatic prism does not exceed one fourth of an inch. Another excellence is the lightness and simplicity of construction and the facility with which it may be adapted to the ordinary microscope. In microscopes having a horizontal arm, the ordinary compound body can be changed for the binocular body and either may be used at pleasure. The instrument of this kind made for the writer gives great satisfaction

to all who have seen it. The stereoscopic effect is perfect; vascular and cellular tissues, and mucous membranes are shown in bold relief; and a magnifying power of 200 to 300 diameters can be used with reflected light with entire satisfaction. With transmitted light the higher powers can be used on suitable objects.

Note.—There is one defect in this form of binocular microscope, viz., object glasses of large angular aperture take in light from so great a field that a portion of light enters the branch of the compound body on the same side from which it originates. This gives, with *low powers*, as the 1 inch and 2 inch objectives of large apertures, a supernumerary image that interferes somewhat with the definition of that part of the field under examination. This defect diminishes as the objective is removed to a greater distance from the prism. If this defect can be obviated, this form of binocular microscope will undoubtedly prove greatly superior to all other forms yet devised. M. C. WHITE.

New Haven, Dec. 7, 1860.

7. *Tolles' Orthoscopic Eye-piece.*—Among the recent valuable improvements of the microscope we notice as worthy of mention, a new form of eye-piece made by Mr. R. B. Tolles, of Canastota, N. Y. This is a modification of the Solid Negative Eye-piece for which Mr. Tolles received a patent, Sept. 1855. The new eye-piece consists of a double convex field-lens, about three-fourths of an inch thick, and a plano-convex eye-lens. The image is formed in the solid substance of the field-lens. This instrument is so constructed as to give a flat field, the central and lateral portions being in focus at the same time, and the magnifying power is the same throughout, so that lines are shown perfectly straight in whatever part of the field they may be seen. Mr. Tolles also combines a micrometer with this eye-piece, by constructing the thick field-lens of two parts cemented together and by ruling micrometer lines on one of the plane surfaces of union. This eye-piece either with, or withont the micrometer is highly satisfactory, giving very fine definition throughout the entire field. This eye-piece will be received with great favor by all who work with the microscope. M. C. W.

8. *Contributions to Analytical Chemistry.*—From an elaborate memoir by H. ROSE, we extract the following notices which are of special interest and importance.

Alumina from Lime and Magnesia.—In the ordinary method of separating alumina from lime and magnesia by means of ammonia, the precipitate of alumina is apt to contain portions of the carbonates of the earths, which of course cannot be removed by washing. To avoid this difficulty, it is only necessary after precipitating by ammonia, to boil the whole gently until there is no longer any smell of free ammonia. In this manner, the alumina is completely precipitated while the whole of the carbonate of lime or magnesia is decomposed and dissolved by the ammoniacal salt present. It is of course necessary that chlorid of ammonium or some other ammoniacal salt should be present in sufficient quantity.

The precipitated alumina is very difficult to wash out upon the filter; it is therefore better after bringing it completely upon the filter, to dry the whole partially till the alumina has shrunk together and just moistens the paper when pressed against it. The alumina may then be easily and

completely washed with hot water. The separation of lime from alumina by this method is complete, but extremely small traces of magnesia usually remain with the alumina.

Separation of Oxyd of Iron from Lime and Magnesia.—By precisely the same method, oxyd of iron may be separated easily and completely from both lime and magnesia. The oxyd of iron may be readily washed out by hot water, and is not gelatinous like alumina.

Separation of Alumina and Iron from Manganese.—Alumina may be easily separated from manganese by the same method. The precipitated alumina sometimes however contains traces of manganese which are too small to be detected by the blowpipe. The same process may be employed directly in separating manganese from iron, when the quantity of manganese is comparatively small. When however this is not the case, the precipitated oxyd of iron contains a considerable quantity of manganese which cannot be removed by boiling with the solution. The oxyd of iron must then without previous washing be dissolved in chlorhydric acid, again precipitated with ammonia, and the solution boiled till the free ammonia is expelled. It is also necessary in separating the bases by this process to bring the solution to the boiling point before adding ammonia, and to boil without intermission till all the free ammonia is expelled. In this manner, we avoid the formation of traces of sesquioxyd of manganese. When iron, manganese, alumina, lime and magnesia are present, and the quantity of magnesia is not too large, the solution may be saturated with chlorine, precipitated by ammonia, and the alumina, iron and manganese separated from the other bases by boiling with the solution. The manganese may then be separated from the alumina and iron by a precisely similar process.

Separation of Manganese from Magnesia and Lime.—This is best effected by adding acetate of soda to the solution, heating and passing a current of chlorine gas through it while hot. The purple red solution is to be supersaturated with ammonia and boiled till the free ammonia is expelled. The manganese is precipitated as sesquioxyd, while the magnesia remains in solution. When alumina and magnesia are present with the manganese, it is best to precipitate the alumina by carbonate of baryta, and then to separate the two other bases by the method already described. To separate manganese from lime, chlorine may be passed directly into the solution; ammonia is then to be added and the whole boiled as before. When alumina, manganese, lime and magnesia are present the dilute solution is to be oxydized by chlorine, and then the alumina and sesquioxyd of manganese precipitated by ammonia and the solution boiled till the free ammonia is expelled.

Separation of Strontia from Lime.—The best method of separating these bases, according to Rose, is the old process of Stromeyer, viz: by treating the nitrates with anhydrous alcohol, which dissolves the nitrate of lime. This process may be greatly improved by using a mixture of equal volumes of ether and alcohol. In this mixture the nitrate of lime easily dissolves, while the nitrate of strontia is almost absolutely insoluble.—*Pogg. Ann.*, *No.* 6, 1860. W. G.

TECHNICAL CHEMISTRY.

9. *Test for Fusel Oil;* by W. STEIN.—Small bits of porous chlorid of calcium having been placed in a beaker glass, portions of the spirit which is to be tested are added until the mass is moistened to such an extent that it appears wet. The beaker is then covered with a glass plate and left to itself. If the spirit contains fusel oil, the odor of the latter may be detected after a while in the beaker, being still more strongly manifest, after the lapse of several hours. When only minute traces of fusel oil are present, one must allow the mixture to stand for a considerable time, before smelling of it.

According to Stein, this method is only a modification of the common test in which the spirit to be investigated is thrown into warm water. Since the impossibility of perceiving small portions of fusel oil in spirit depends upon the fact that the odor of this substance is masked by that of the alcohol vapor which is evolved at the same time, the formation of the latter must be prevented if one wishes to smell the fusel oil alone. This result may be attained either by diluting the alcohol with water, or better, as previously stated, by mixing with it an excess of chlorid of calcium, with which substance the alcohol combines so strongly, that its odor can no longer interfere with that of the fusel oil.—From *polytechnisches Centralblatt*, 1859, p. 1627; in Dingler's *polyt. Journal*, clv, 158.

10. *Value of different kinds of Soap;* by R. GRAEGER.—Complaints of consumers in regard to the value, or rather efficacy of samples of soap, which to the best of the manufacturer's knowledge, have been well prepared, are not uncommon.

It is very probable that the usual explanation which is offered, whenever a soap fails to fulfil the expectations of its consumer, viz: that it contains too much water, may be in many cases correct. Admitting this, and various other contingences, which are of importance in deciding upon the value of a soap, there appears to be another obvious reason why different soaps containing equal amounts of water may still possess different degrees of efficacy.

It is evident from the different equivalent weights of the various fatty acids, that the amounts of caustic alkali taken up by them in the formation of soap must be of unlike magnitude.

If it be true, that the detergent power of soap is entirely dependent upon the amount of alkali which it contains, of course it follows that those soaps which contain the largest proportion of alkali,—or in other words, those containing a fatty acid, the equivalent weight of which is small,—must be the most efficacious.

Since the difference between the equivalents of the common fatty acids are not large, these considerations are perhaps of little or no importance in so far as concerns the consumption of soap in household economy—the total amount used in a single family, being but small. In a manufacturing establishment, however, where fifty or a hundred thousand pounds of soap may be used, in the course of a year, differences which cannot be deemed insignificant, must exhibit themselves.

For example, the equivalent weights of several soaps, (regarded as anhydrous,) in common use, are as follows:

Oleic acid (red oil) soap,	- - -	= 3800·95
Palm oil "	- - -	= 3588·85
Tallow "	- - -	= 3300·95
Cocoanut oil "	- - -	= 3065·45

Calculating from these weights how much of each of the other soaps would be required to replace 1000 pounds of tallow soap, the following quantities will be found:

1151 lbs. of Oleic acid soap,	*i. e.*,	15·1 p. c.	more than	of tallow soap.
1087 " " Palm oil soap,	*i. e.*,	8·7 "	"	"
928 " " Cocoanut oil soap,	*i. e.*,	7·2 "	less than	"

Differences like these must certainly be of importance in practice; and could, doubtless, be detected by direct experiment, if any one would undertake a comparison of the various kinds of soap,—a research which would not be easy however.—*Bœttger's polytechnisches Notizblatt*, 1860, xv, 65.

11. *Pig-iron which contains Copper cannot be puddled;* by Dr. C. List.—It has been stated as a matter of belief among practical iron-workers in Germany, that pig-iron which contains copper cannot be puddled; assertions having even been made, that when one puddler wishes to annoy another he will sometimes throw a bit of copper—a small coin, for example, into the furnace, so that the iron cannot be made to "rise."

Without giving full credence, as yet, to this statement, Dr. List mentions that he has observed two instances, which go to prove that it may be correct. In the case which he has more particularly described, none of the phenomena which ordinarily occur, when iron is puddled, appeared. Some 400 lbs. of pig-iron having been placed in the furnace were melted in the course of half an hour,—at which time a sample taken from the molten mass was perfectly white, but the usual evolution of carbonic oxyd and consequent swelling, or "rising" up of the mass of scales, &c., about the iron, did not ensue. On the contrary, by the time that the balling together of the iron should have commenced, it was evident, that the charge could not be worked off; it was therefore removed from the furnace, after having remained there about three quarters of an hour. As the melted metal was flowing out, it emitted numerous beautiful blue sparks, which were also produced, when the metal in the furnace was stirred. The sparks were regarded by the workmen as an indication that the iron contained copper.

The amount of metallic iron, which remained, weighed 240 lbs., 160 lbs. having been lost in the scales and slag. Analyses [for details of which, see the original memoir,] were made of the original pig-iron, (I.); of the sample taken, as previously mentioned, from the melted iron, as it lay beneath the scales, (II.); and of the iron, after it had been removed from the furnace, (III).

	I.	II.	III.
Silicon, - - - -	1·32	0·29	...
Sulphur, - - - -	0·28	...	0·20
Manganese, - - -	3·56	...	0·48
Copper, - - - -	0·35	0·38	0·57

It was evident, therefore, that the 400 lbs. of pig-iron used did really contain nearly a pound and a half of copper. It appears, moreover, that copper cannot be removed from iron by puddling. Calculating how much copper ought to be left in the iron which was finally removed from the furnace, in case none had been lost in the slag, it is found that there should be 0·58 per cent, almost exactly the quantity obtained in analysis No. 3.—*Dingler's polytechnisches Journal*, 1860, clv, 22.

F. H. S.

12. *Preparation of Oxyd of Lead free from Copper and Iron;* by TH. WICHMANN.—Of the many plans which have been proposed for utilizing the sulphate of lead which is formed in considerable quantity as a secondary product in the preparation of alumina mordants at print works, the method of reducing it in furnaces to the metallic state has been most frequently resorted to, since the quality of the lead thus prepared is of peculiar excellence. Instead of thus reducing the sulphate of lead, Wichmann proposes to convert it directly into oxyd of lead, maintaining that the oxyd thus prepared being uncontaminated with copper or iron will be well suited for the manufacture of white glaze for pottery—[probably also for making flint glass] it being somewhat difficult to obtain in commerce oxyd of lead which does not contain traces of these impurities. In his method, suggested by that of Mohr* for preparing caustic baryta, a quantity of caustic soda lye of from 28° to 30° (B.)= about 1·25 sp. gr., having been brought to boil in an iron kettle, the sulphate of lead is added to it little by little, with constant stirring, oxyd of lead and sulphate of soda being produced. The amount of sulphate of lead which shall be added to a kettle of soda, and which is somewhat less than the quantity which theory would indicate, must be determined once for all by direct experiment,† sulphate of lead being added until the sharp caustic taste of the soda is no longer manifest. It is well, however, to leave some free soda in the solution lest a portion of undecomposed sulphate of lead should contaminate the oxyd of lead which is formed, although a small amount of the latter will combine with the soda and remain in solution. During the boiling, the decomposition is rapid, and complete, unless the soda lye contained much carbonate of soda in which case a white scum of carbonate of lead will separate.

* To a boiling solution of caustic soda, of 1·10 to 1·15 sp. gr., of known strength an equivalent weight of powdered nitrate of baryta is added. As soon as the baryta salt has completely dissolved, the hot solution should be rapidly filtered in order to separate any sulphate or carbonate of baryta which may have been formed from impurities of the soda, and the filtrate set aside in a cool place. An abundant crop of crystals of hydrate of baryta soon forms. These crystals are to be drained from the solution of nitrate of soda, upon a funnel loosely plugged with cotton and the drying completed [according to Mohr] by means of a centrifugal machine. If required for purposes where the adhering nitrate of soda should be avoided the hydrate of baryta may be re-crystallized. In place of the nitrate of baryta one may use chlorid of barium—or in place of the soda, potash; but as a rule the presence of chlorine in the product would be more objectionable than that of nitric acid. On the small scale the process of boiling is best conducted in a glass flask, but where larger quantities are desired a covered iron kettle may be used—as in the common method of preparing caustic alkalies.—From *Archiv der Pharmacie,* lxxxviii, 38; in *Chemisches Centralblatt*, 1856, [N. F.,] i, 834.

[† For a ready method of obtaining the weight of moist sulphate of lead, see Mr. F. Mayer's paper in the March No. of this Journal, [2], xxix, 280.]

When the proper quantity of sulphate of lead has been added to the lye and the decomposition is finished, the contents of the kettle must be thrown into a vessel containing water in order that the sulphate of soda which has been formed may be retained in solution, which would not be the case if no water were added to the mixture. The oxyd of lead, which is in the form of exceedingly fine crystalline scales of a light yellowish red color* and of great purity, is readily deposited; after being thoroughly washed, to remove the sulphate of soda, it is dried and finally ignited in a reverberatory furnace—the charge being subsequently allowed to cool as slowly as possible.

As thus prepared the oxyd is an exceedingly soft powder of a yellowish red color like prepared litharge; it contains about 2 per cent of alumina which can not readily be removed, but which is not at all detrimental to its use in glazing pottery, and also a larger or smaller quantity of carbonate of lead according as the soda lye was more or less contaminated with carbonate of soda.

The crude sulphate of lead as it comes from the print works should be agitated and washed with water—or, better, forced through a fine seive in order to break up lumps and to remove any foreign substances,—before being used.

The residual solution of sulphate of soda being evaporated together with the first portions of the wash water, affords Glauber's salt containing alumina, plumbate of soda, acetate of soda (the acetic acid and alumina being both derived from the crude sulphate of lead), and chlorid of sodium (from the soda lye); being free from iron, it is suitable for glass maker's use.—From *Polytechnisches Centralblatt*, 1860, p. 411; in *Polyt. Notizblatt*, xv, 184.

13. *Cleansing of Mordanted Cloth before Dyeing;* by J. Lœwenthal.—It is well known that cotton cloth upon which alumina or iron mordants have been printed must be submitted to the so-called dunging process before it can be dyed.

The action of the ingredients used for dunging is:—1. to completely fix the mordants: 2. to remove the substance (starch, gum, &c.,) with which the mordant was thickened for printing; (3. as well as to remove the excess of mordant, and by combining with it prevent it from soiling those portions of the cloth which are to remain uncolored.—E. Kopp.)

Giving special prominence to the second of these desiderata, that of removing the thickening agent, Lœwenthal proposes to employ diastase, as contained in malt, in order to convert the starch into sugar thus rendering it readily soluble so that it can be easily removed from the cloth.

By direct experiment he has satisfied himself that the addition of malt to baths of bran (previously boiled) or of cowdung, is decidedly beneficial; cloths which have been printed with an alumina mordant thickened with starch being very rapidly cleansed in this manner. With iron mordants a somewhat longer time is required than with those of alumina but they are nevertheless cleaned much more rapidly than when no malt is used.

A temperature of 35° to 40° R. [=111° to 122° F.] is sufficient that the malt shall act powerfully.

* If a more concentrated soda lye be used, say of 40° B., somewhat larger crystals of a dark red color are formed.

When the dunging bath contained water glass (sesquisilicate of soda) the use of malt gave rise to the formation of spots upon the cloth in the process of dyeing. The author thinks, however, that this objection might perhaps be obviated if purer diastase were used instead of malt.

In this connection Barreswil remarks that he has employed pepsine with success in removing colors fixed with albumen.—*From Journal für praktische Chemie*, lxxix, 480; *in Répertoire de Chimie Appliquée*, ii, 168.

14. *Incineration of Filters.*—The great difficulty with which in many cases, the last portions of the carbón of a filter are consumed when ignited in a porcelain crucible is a fact well known to analysts. It does not appear, however, that the following simple method of obviating the difficulty—as practised in the laboratory of Prof. Scheerer in Freiberg—has ever received the publicity which it deserves.

Whenever a filter upon which a substance capable of injuring platinum has been collected is to be incinerated, the porcelain crucible or capsule in which the process is to be conducted should be placed *within a vessel of platinum* of similar form, and the whole ignited in the usual way.

Whether the greatly accelerated rapidity of combustion of the carbon, which ensues depends upon a more equable distribution of heat brought about by the greater conducting power of the metal,—an explanation which is current for the somewhat analogous case of copper-coated glass flasks, or whether as seems probable, the power of the porcelain vessel to absorb heat be really increased by the interposition of the platinum; whether both these causes be of influence, or the result depend upon another less apparent reason; or finally whether vessels of some other metal would not be preferable to those of platinum; are questions which we do not propose to discuss in this connection. We desire only to give currency to the *fact* to which attention has been called, feeling assured that the chemist who has once employed this method to destroy a refractory filter will ever afterwards bear it in mind. F. H. S.

15. *On the occurrence of the Hydrocarbon* C_4H_2 *in Coal Gas.*—In describing the explosive red compound* which he obtained by passing a current of street gas through an ammoniacal solution of dichlorid of copper, Bœttger (*Ann. Ch. u. Pharm.*, cix, 353), called attention to the fact that an abundant evolution of gas ensues when the compound is treated with moderately concentrated chlorhydric acid. This gas has recently been more carefully examined by Berthelot (*Comptes Rendus*, l, 805), who finds its composition to be C_4H_2, and calls it *acetylene*, or quadricarbide of hydrogen. It is evidently the prototype of a series of hydrocarbons, the general formula of which is $C_{2n}H_{2n-2}$. According to Berthelot, acetylene is formed whenever olefiant gas, or the vapor of alcohol, ether, aldehyd, or of wood-spirit is passed through a red hot tube.

* This explosive compound has also been described by Quet, (*Comptes Rendus*, 1858, xlvi, 905), who obtained it when the gas prepared by decomposing alcohol by a series of electric sparks was treated with an ammoniacal solution of dichlorid of copper. It was observed in 1839,—long before the experiments of the chemists above mentioned, by Prof. Torrey of New York, on the occasion of its occurrence in the copper service pipes at that time in use for distributing gas. (See *American Gas-Light Journal*, Oct. 1859; *Répertoire de Chimie Appliquée*, i, 493; compare Bœttger's *Notizblatt*, 1860, xv, 117), (note).

It is formed also when the vapor of chloroform is brought in contact with red hot copper; and is moreover a constituent part of illuminating gas. Of the foregoing sources, ether furnishes it in the greatest abundance. In whichever of these methods the gas may have been prepared, however, it is always mixed with a large quantity of other gases, from which it must be separated in the manner indicated by Bœttger before it can be obtained in a state of purity.

Acetylene is a colorless gas, somewhat readily soluble in water, having a disagreeable and characteristic odor, and burning with a very luminous and smoky flame. Its sp. gr.$=0 \cdot 92$; it has not been liquified either by cold or pressure. Mixed with chlorine it detonates almost immediately even in diffused day light, carbon being deposited. When exploded in the eudiometer 1 volume of acetylene consumes 2·5 vols. of oxygen and forms 2 vols. of carbonic acid. Its formula represents 4 volumes of vapor.

In general the properties of this gas are similar to those of olefiant gas (C_4H_4); and by combining with bromine, sulphuric acid, the elements of water, and with hydrogen, it forms compounds parallel to those formed in similar cases by olefiant gas.

[In a technological point of view this gas is of great interest; for not only is Berthelot's observation of the first importance in itself as a contribution to the chemistry of gas lighting, but further investigation of the subject will no doubt lead to the elucidation of several of the vexed questions upon which gas engineers are at variance. For example, the fact that a quantity of useful gas—probably much more luminous than an equal bulk of olefiant gas, is produced when the latter is strongly heated, must be a most acceptable support to those who advocate "high temperatures" as the best system of gas making;—as it must also materially modify, the prevailing notion that the luminiferous properties of olefiant gas are entirely destroyed by such treatment. In a word, those who from theoretical premises have satisfied themselves that the employment of "high temperatures" in gas making is pernicious, and have therefore opposed this system, must reconsider their argument.*

Again, the knowledge that a luminiferous gas so readily soluble as acetylene occurs in coal gas is a subject most worthy the consideration of those gas engineers who advocate the use of much water in the purification,—or who, in the terse language of the opponents of their system, "would 'scrub' the life out of the gas!"

The occurrence of acetylene, and no doubt of some of its homologues, in illuminating gas is moreover another evidence of the error, still frequently fallen into by chemical writers, of attributing all the luminif-

* We would in no wise affirm either that the researches of Berthelot and Bœttger have demonstrated the excellence of the system of high temperatures, or that it would be advantageous in practice to decompose olefiant gas for the sake of the resulting acetylene, nor would we in any way imply that the constantly increasing growth of this system is due to the good quality of the gas produced,—for this last is in many instances most certainly not the case; the rise and progress of the system abroad having been mainly due to a most unhealthy competition among rival gas companies. We urge only that the system of high temperatures contains one favorable element which had hitherto been overlooked by chemists. F. H. S.

erous power of coal gas to the olefiant gas, and homologues of the series $C_{2n}H_{2n}$, contained in it. The incorrectness of which view has been shown by Frankland, (*Ann. Ch. u. Pharm.*, lxxiv, 57. See also lxxxii, 1), by Lewis Thompson (Ure's *Dictionary of Arts*, &c., 4th edit., Boston, 1853, i, 438), and by others, and has been recognized, we believe, by every chemist who has latterly made a special study of the technology of gas making.

Berthelot promises soon to publish the results of his examination of the compounds which acetylene forms with chlorid of copper and with nitrate of silver* and of mercury, and of the analogous compounds which the last two salts form with olefiant gas. He also alludes to a method of isolating olefiant gas, the publication of which can hardly fail to interest gas makers.

It is to be hoped that in the same connection M. Berthelot will make some slight allusion to the labors of Edmund Davy, (*Annalen der Pharmacie*, xxiii, 144; from the *Records of General Science*, Nov. 1836, through *Journal de Pharmacie*, *Mars.*, 1837, p. 143), who obtained from the decomposition by water of the brown mass—"carbide of potassium"—which occurs in the preparation of potassium from burnt tartar and charcoal, a gas† of the same composition (C_4H_2) and of identical properties with that which forms the subject of this notice.

Besides this, the observations of Courbe, (*Annales de Chimie et de Physique*, 1838, (2,) lxix, 184; compare Gmelin's Hand Book, x, 411, and xi, 395), should be remembered. In a liquid which was deposited by illuminating gas (from rosin) when this was subjected to pressure, Courbe detected compounds, (for example, "B"$=C_{10}H_8$, and "F"$=C_{12}H_{10}$), which accord with the general formula of the acetylene series, and which in view of their origin would seem to be entitled to a place therein, at least until their right to the position shall have been disproved. So also, perhaps, with the campholene ($C_{18}H_{16}$) of Delalande, (*Ann. Ch. et Phys.*, [3], i, 125).

While the labors of these chemists do not in the least degree detract from the intrinsic value of Berthelot's observations, they should nevertheless neither be lost sight of nor passed over in silence]. F. H. S.

16. *Action of Carbonate of Soda on Cast-Iron.*—In July, 1857, C. Tissier, director of the Aluminium Works at Amfreville, published in the *Technologiste*, (p. 357), some interesting experiments on this subject, an abstract of which we now make from Dingler's Polytechnisches Journal, cxlvi, 118, (1857). Tissier's attention was first drawn to the fact that the mixture of carbonate of soda, chalk, and charcoal used in the manufacture of sodium, notwithstanding the great excess of carbon it contains—does not affect the malleability of the iron of the retorts which are employed. He found further, when a piece of *cast iron* was submitted to a high temperature, with this mixture, that it was first converted into *steel*,

* Compare Bœttger, *loc. cit.*, also Vogel and Reischauer, in Kopp and Will's Jahresbericht der Chemie, für 1858, p. 208.

† This gas was called klumene by Leopold Gmelin, in his Hand Book (Cavendish Soc. Ed., viii, 150).

and finally into *malleable iron.* This led him to try the effect of the action of carbonate of soda alone on both malleable and cast iron—malleable iron thus treated, remained unchanged, while the soda salt extracted the carbon and silicium from the cast iron, thereby converting it into infusible malleable iron.

If a specimen of pig-iron (that experimented on contained 6·6 pr. ct. of silicium and free carbon) be exposed for several hours at a red heat in a crucible containing an excess of carbonate of soda, the following reactions may be observed: As soon as the temperature is sufficiently elevated the mass commences to rise and large bubbles of carbonic oxyd are given off, burning with a yellow flame. If after the evolution of carbonic oxyd has ceased, the fire is allowed to go down and the iron taken out with tongs, and freed from adhering salts by means of a hammer and by water, the metal exhibits a completely etched surface, although the form of the mass is unaltered—it may be drawn out under the hammer and forged either hot or cold, and the granular fracture of the cast iron is replaced by a fibrous crystalline texture—the mass is porous, the little cavities being filled with white silicate of soda, formed from the silicium contained in the metal. The iron thus obtained is scarcely attacked at all by chlorhydric acid in the cold, and but slowly even when heated. Dilute nitric acid acts upon it with energy, but still not so rapidly as in the case of ordinary malleable or cast iron.

Tissier considers it conceivable that this action of carbonate of soda not only extracts the carbon and silicium but also must remove the phosphorus and sulphur contained in the iron. It is further possible that the iron takes up a portion of sodium, which does not injure it, but on the contrary the metal acquires desirable properties as evinced by the fact of the dealers being very willing to purchase the worn out retorts from the sodium works. If sodium be not thus taken up, we must assume that for every equivalent of carbonic oxyd an equivalent amount of anhydrous soda is formed. Tissier suggests that in the process of annealing or the conversion of cast iron into malleable iron, now accomplished by packing and heating for a long period with substances rich in oxyd of iron, it may be possible to substitute fusion with carbonate of soda, it possessing the advantage that the metal can be removed from time to time to watch the progress of the conversion into *steel* or *malleable iron.*

The author hoped by this method to convert large masses of cast-iron into malleable metal, such as heretofore could only be obtained by forging, but the length of time required for the conversion of a mass of any considerable thickness and the porosity of the iron obtained, present practical difficulties requiring some modification to overcome them. With smaller castings, however, the action, even when superficial, imparts to them great toughness so that they no longer are liable to fracture. The amount of carbonate of soda required, when properly used, is inconsiderable, but it should be pure, or if the commercial article be used, it must first be heated with carbon in order to reduce the sulphate of soda to sulphid of sodium, as the alkaline sulphates have a powerful action on iron at a red-heat.

II. GEOLOGY.

1. *Geological Survey of Canada.—Report of Progress for* 1858. Montreal, 1859, 8vo, pp. 263, with 4 Maps and Sections.—In the present volume Sir William Logan continues his description of the distribution of the rocks of the Laurentian series. These stratified rocks, the oldest not only of America but probably of the world, have long been regarded by the officers of the Geological Survey of Canada, as identical with the oldest crystalline rocks of Scandinavia and Scotland; and Sir Roderick Murchison in his late admirable investigations of the geology of his native Highlands has recognized the parallelism, and adopted the name of Laurentian for the oldest Scottish rocks, which he had formerly designated as *fundamental gneiss*. Laurentia is destined to be a domain second only in importance to Siluria, embracing, as it does, in Canada, a mass of strata probably equal in amount to the whole palæozoic series in its greatest development, and including not less than three limestone formations, the most considerable of which is 1000 feet in thickness. These are associated with gneiss, quartzite with garnets, and great beds of rock made up of triclinic feldspars, (labradorite, or andesine,) often with hypersthene or pyroxene. Argillites appear to be wanting throughout the system. The whole of this great series of sediments is profoundly altered, yet the existence in the limestones of forms resembling *Stromatocerium*, not less than the presence of beds of graphite, iron-oxyd and metallic sulphurets, points to the probable existence of life during the deposition of these most ancient strata. (This Journal, [2], xxx, 134.)

Intrusive rocks are not generally met with in the Laurentian series, but in the vicinity of Grenville, there are injections of syenite, orthophyre, and dolerite, making four distinct periods of eruption, of which three at least were anterior to the deposition of the lowest Silurian strata.

The difficulties attendant upon the investigation of a disturbed region like that presented by the Laurentian rocks in Canada or in Northern New York, are enhanced, by the fact that it is still to a very great extent covered by primeval forests. The outcrop of the limestones, however, is generally marked by valleys, well watered and with a fertile soil which has invited settlers to some distance from the frontier of the region, and the result of two years of investigation has enabled Sir William to trace out the distribution of these limestone bands through the counties of Ottawa and Argenteuil, including fifty miles of the valley of the river Rouge; from the map of this exploration, which accompanies the Report, we may get an idea of the complexity of structure in this region. After some new observations upon the great beds of magnetite belonging to this series, and the veins of galena, which cut alike the Laurentian strata and those of the Calciferous sandrock, the report goes on to describe the copper deposits of the Eastern Townships of Canada. These occur in strata which overlie the Hudson River shales, and are named the Quebec group. The copper occurs both in the altered and unaltered strata, and is found alike in dolomites, steatites, argillites and silicious chloritoid slates, generally disseminated in the beds, but frequently in veins of quartz and bitter spar, and more rarely with specular iron and native gold. The copper itself is rarely native, generally occurs as erubescite, copper glance or copper pyrites. The famous Acton mine is a deposit between dolomites

and shales, and forms apparently a lenticular mass. It is a conglomerate of which the sulphurets of copper form the cement, and encloses rounded and angular fragments of calcareous and silicious rock. Similar conglomerates, but much less rich in copper, occur in other localities in the same region.

Mr. Alexander Murray makes a report upon the Thessalon and Mississauga rivers, giving the results of his topographical examinations, and contributing farther information as to the structure of the Huronian rocks, which upon Lake Huron attain a thickness of about 10,000 feet and are intercalated between the Laurentian and Lower Silurian series. They are made up of quartzites with two great bands of slate conglomerates, and masses of interstratified diorites, besides two or more bands of limestone, whose distribution has been most serviceable in making out the structure of the region. The copper of the Bruce and Wellington mines, of Root River and Echo Lake occurs chiefly in veins cutting the diorites of this series, although the metal is also found disseminated in some of the beds. Mr. Murray has considered the disturbances of this series of rocks with particular reference to the distribution of the copper veins, and has given us a section, together with a map showing the distribution of the Huronian limestones. A remarkable dislocation occurs in the valley of the Thessalon, bringing the Laurentian gneiss in contact with the upper portion of the Huronian series by a vertical displacement of 9,200 feet.

The results obtained by Mr. J. Richardson in an examination of a part of the district of Gaspé are next given, with a map showing the distribution of the rocks. The Shickshock mountains, which are a continuation of the Notre Dame and Green Mountains have a synclinal form: and appear as a mass of crystalline schists in great part epidotic, quartzose and chloritic, running about E.N.E. for a distance of sixty-five miles and rising in points to about 3700 feet. Along their northern base the slates and conglomerates of the Quebec group, are seen dipping southward, but around their southern slope, repose the Devonian rocks. Associated with these crystalline schists are great masses of serpentine, which at Mt. Albert are seen sweeping around the base of the hills. A remarkable section here exhibits a synclinal form with an overturn dip on the south side, so that the serpentines, which are really beneath the epidotic and hornblendic and chloritic rocks, seem to overlie them. That portion of the serpentine which succeeds to the black hornblende slate is beautifully and distinctly stratified. The weathered surfaces exhibit opaque white or fawn colored bands of from one-eighth of an inch to an inch in breadth, with thinner red partings. Within, the rock is dark brown or greenish, with deep red bands, sometimes including grains of chromic iron and diallage, as well as thin layers of asbestus. The thickness of this stratified portion is about 400 feet; it is succeeded by about 600 feet of dark green serpentine, which is not distinctly stratified, and reposes directly upon black slates and limestones. The facts already published by the Canadian Survey have shown that it is impossible to regard the great masses of serpentine so common both in the Laurentian and Silurian series, as anything other than sedimentary deposits, and we think it indeed a question whether serpentine ever takes the form of an intrusive rock. (See further on this subject Mr. T. Sterry Hunt, in the Report for 1853–56, pp. 432 and 480, and this Journal, [2] xxv, 217, xxvi, 234.)

In the present Report Mr. Hunt gives the results of a series of investigations upon the intrusive rocks of the vicinity of Montreal. These include orthophyres, some of which are very beautiful porphyries, and a great variety of trachytic rocks, passing into granites on the one hand and to phonolites on the other, besides diorites, augite rock and dolerites, some of them containing large portions of olivine. These investigations include a great many analyses of the rocks and their component minerals, and are followed by the continuation of Mr. Hunt's researches on the formation of magnesian rocks. With this investigation our readers have already been made acquainted. (See this Journal, [2], xxviii, 170, 365, xxix, 285.)

By way of Appendix to this Report, we have a catalogue of the plants and animals collected in the counties of Argenteuil and Ottawa by Mr. W. M. S. D'Urban, an accomplished young naturalist now at the Cape of Good Hope, who accompanied Sir William Logan during the summer of 1858—and made as complete a collection as possible of the flora and fauna of the district. A similar collection was made in the Lower St. Lawrence and in the district of Gaspé by Mr. Robert Bell, an assistant of Mr. Richardson. The species were determined in part by Mr. B., and part by Mr. D'Urban, Drs. Dawson, Le Conte, Lea and Mr. Binney. The collection of marine animals, obtained in part by dredging, is considerable, and an important contribution to the fauna of that region. T. S. H.

2. *Geological Surveys.*—Kentucky.—The fourth volume of this Survey now in press contains the stratigraphy and palæontology of all the coalfields of Kentucky excepting a few of the southeastern counties. It is provided with five plates and a great number of comparative sections, illustrative of the general distribution of the coal measures.

Arkansas.—The second volume of this Survey contains a geological description of all the counties not treated of in the first report. Mr. Lesquereux contributes to this volume the palæontological and stratigraphical descriptions of the coalfields of the State—a comparison of botanical distribution with the geological formations—and a catalogue of the phenogamous plants of Arkansas with short descriptions of the plants useful in agriculture, medicine, &c. This catalogue contains Nuttall's plants with those found by the Survey. The Palæontology is illustrated by six plates.

Illinois.—We have elsewhere stated, (p. 125,) some of the results of this State survey under the able direction of Mr. Worthen—the publication of this very valuable Report now awaits only the needful appropriation of money which a State so intelligent and prosperous as Illinois, cannot withhold—for a work which will be at once so useful and so honorable to her enlightened liberality.

Texas.—We hear with great regret that the able Director of this Survey has been removed from his post to make way for another person—without the means of judging of the circumstances of the case, we know too well Dr. Shumard's ability to discharge his duties, to suppose that Science will gain by the change—which we have reason to fear has been brought about by means of personal influence with the Governor of the State aided by the power of some influential scientific names.

California.—Prof. Whitney whose departure for his post of duty we noticed in our last—has reached San Francisco with all his party and outfit without loss or delay—and was making preparations to enter at once on the active duties of his post.

CANADA.—The results of the labors of Sir William Logan and his able corps of associates—as far as they have been made public are noticed on page 122.

It is plain to all who take an interest in the progress of geology in the United States, that an active discussion is now imminent on the questions touching Barrande's primordial zone. In this discussion the 'Taconic System' of Emmons so long suppressed, will probably be again put forward. Already the contestants are sharpening their weapons, and we will not anticipate the discussion farther than to intimate that the views of the distinguished French geologist will find a warm opposition at the hands of the New York State Palæontologist, and probably also with some of the gentlemen of the Canadian Survey. The subject is already before the Boston Society of Natural History, where Mr. Marcou appears as the advocate of the Taconic System. This geologist finds evidence of the existence of the primordial fauna not only in the metamorphic black slates of Georgia in Vermont, but at the Falls of Montmorency, in the region between the Upper Mississippi and Lake Superior, near Lake Michigan, on the north shore of Lake Superior near the Pic, in the Black Hills of Nebraska, and in Texas.

NEW YORK.—Prof. Hall's third volume (text) on the Palæontology of New York, so long looked for, has been in print for some time, but has been held back to ensure completeness under the important genus Eurypterus. It is now before us, and we are assured by him that it will be speedily distributed. The Introduction handles with masterly skill the difficult subjects connected with the proper classification of the lower horizons of life in our planet. A review of this important chapter with reference to the views of Barrande will probably appear in our next. The plates for this volume are not yet all ready for delivery.

3. *Descriptions of new species of Crinoidea and Echinoidea from the Carboniferous rocks of Illinois, and other Western States ;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 19. Proceed. Acad. Nat. Sci., Pa., Sept., 1860.—This paper contains descriptions of twenty-nine new species. *Platycrinus*, 3 species, *Dichocrinus*, 4 ; *Trematocrinus*, 1 ; *Actinocrinus*, 6 ; *Forbesiocrinus*, 2 ; *Zeacrinus*, 3 ; *Cyathocrinus*, 5 ; *Poteriocrinus*, 2 ; *Archæocidaris*, 1 ; *Palæchinus*, 1 ; *Melonites*, 1. It is suggested by the authors that the genus *Trematocrinus* of Hall is identical with *Goniasteroidocrinus* of Lyon and Casseday. If so, the latter genus will have to take precedence, from priority of publication. H.

4. *Descriptions of New Carboniferous Fossils from Illinois and other Western States ;* by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey, pp. 26. Proc. Acad. Nat. Sci., Pa. Read Oct. 23d, and published Nov. 24th, 1860.—This interesting paper comprises 69 species, all of which are supposed by the authors, to have been heretofore undescribed. They may be enumerated as follows : *Ephenopterium*, 4 species ; *Palasterina*, subgenus *Schœnaster*, 1 ; *Chonetes*, 1 ; *Productus*, 3 ; *Rhynconella*, 1 ; *Athyris*, 1 ; *Pecten*, 1 ; *Aviculopecten*, 7 ; *Avicula*, 1 ; *Myalina*, 3 ; *Solemya*, 1 ; *Leda*, 1 ; *Schizodus*, 1 ; *Cardiomorpha*, 1 ; *Bellerophon*, 1 ; *Pleurotomaria*, 11 ; *Euomphalus*, 2 ; *Naticopsis*, 2 ; *Platyostoma*, 2 ; *Eunema*, 1 ; *Loxonema*, 5 ; *Eulima*, 1 ;

Macrocheilus, 3 ; *Soleniscus*, 1 ; *Orthoceras*, 1 ; *Cyrtoceras*, 2 ; *Nautilus*, 7 ; *Goniatites*, 3.

The authors have established a remarkable new genus of Zoöphytes, *Sphenopoterium*, from σφην, a wedge ; ποτηριον, a cup.

"This small group of corals appears to be more nearly related to *Cyathoceris*, of Edwards and Haime, than to any other genus, either recent or fossil, with which we are acquainted. It differs, however, in having the outer walls perforated, and in being destitute of distinct rays, as well as in the peculiar wedge-like form of the base of the corallum, which is also usually, if not always, free instead of attached."

The authors also describe a new genus of Gasteropoda, *Soleniscus*, to include certain species allied to *Loxonema* and *Macrocheilus*. The illustrations with more extended descriptions will appear in the forthcoming report of the Illinois Survey, which promises to be one of unusual interest. Besides the numerous invertebrate fossils, it will contain illustrations and descriptions of over one hundred new species of fossil fishes of Dr. J. S. Newberry ; a report on the Bryozoa of Dr. H. A. Prout ; a report on Fossil Plants of Mr. Lesquereux and a report on the Lead region of Illinois by Prof. J. D. Whitney. H.

5. *Systematic Catalogue, with Synonyma, &c., of Jurassic, Cretaceous and Tertiary Fossils collected in Nebraska, by the Exploring Expeditions under the command of Lieut. G. K. Warren*, of U. S. Topographical Engineers ; by F. B. Meek and F. V. Hayden.—Of the 276 species and varieties enumerated in the following catalogue, 25 are from Jurassic rocks, 194 from Cretaceous, and the remaining 57 from Tertiary strata. None of the Jurassic species are known to occur in this country east of the Black Hills, or south of the middle of eastern Utah, though some of them will probably be found in New Mexico. One species is believed to be identical with *Ostrea calceola* of Roemer from the Jurassic rocks of Germany, and another (*Ammonites cordiformis*) is probably not distinct from *A. cordatus*, Sowerby, which occurs in the Jurassic series of England, France, Russia, &c. Nearly all the other Jurassic species mentioned in the list are closely allied to forms common in the lower part of that system (the Lower Oolite and Lias) in the old world, and several of them may prove identical on farther comparison.

Of the 194 Cretaceous species the following seven are common to the Nebraska and New Jersey beds, viz.—*Nautilus Dekayi*, *Ammonites placenta*, *A. complexus**, *A. lobatus**, *Scaphites Conradi*, *Baculites ovatus*, and *Gryphæa vesicularis ?* ; and the following five species are probably common to Nebraska and foreign localities, viz.—*Nautilus Dekayi*, *Inoceramus problematicus*, *Gryphæa vesicularis*, *Cucullæa fibrosa*, and *Micorbacia coranula*.

The 57 Tertiary species are believed to be all distinct from foreign forms, and none of them have yet been found in this country east of Nebraska, or south of northeastern Utah. They are all, so far as known, extinct species."

The Palæontological portion of Lt. Warren's report is now completed, containing extended discriptions and comparisons of over three hundred species of fossils, from all the formations known in the northwest. The illustrations comprise over one thousand figures of Mollusca and occupy forty-five quarto plates.

6. *Observations on the Cretaceous Strata of Texas;* by B. F. Shumard, M.D., (Trans. Acad. Sci. St. Louis, vol. i, No. 4, p. 582).—The leading points in Shumard's paper bearing upon the disputed geology of the southwest are these. First he recognizes at the base of the Cretaceous series of that region, what he calls the Arenaceous group, and places it on a parallel with our No. 1, of Nebraska, (Miocene of Marcou and Prof. Heer). This is as was shown by Messrs. Meek and Hayden in 1857* a part of Marcou's Jurassic and Triassic of the *Pyramid Mountain Section.* It is also the horizon of their Cretaceous leaves of Nebraska and Kansas as Shumard states, and he finds great numbers of Cretaceous fossils in it, though no leaves.

Above this he finds other beds which he places on a parallel with No. 2 and 3, of the Nebraska section, and shows that they are the horizon occupied by Marcou's *Ostrea Marshii* and *Gryphæa dilatata,*† upon which he rests his claims to the discovery of the Jurassic of the southwest.

These beds Meek and Hayden had also placed on a parallel with No. 2 and 3, of the Nebraska section, as Shumard states. Thus as is seen, all explorers concur in the opinion that what Marcou calls Jurassic, at least, at the localities where he found fossils, is Cretaceous. There doubtless are Jurassic and Triassic rocks in New Mexico, and possibly in parts of Texas, but all the fossils Marcou relied upon to prove it, are Cretaceous species, as already stated. And the Jurassic and Triassic of his section, at the main localities cited, are Cretaceous beds. Shumard's paper is an important one, and when we consider his opportunity to understand these matters in making State explorations, is entitled to great weight. M.

7. *Die Silurische Fauna des westlichen Tennessee;* 4to. pp. 97; three lithographic and two copper plates; by Dr. Ferdinand Roemer; Breslau, 1860.—In this work Dr. Roemer has noticed and figured 58 species of fossils from the Upper Silurian rocks of Tennessee. Of these he identifies 22 as occurring in the Niagara group of the State of New York, and 28 in Europe, in the Wenlock formation of England and in the limestones of the Scandinavian Islands, Gothland and Malmö. The most interesting are those which he has described as fossil sponges under the genera *Astylospongia Palæomanon* and *Astræospongia.* The specimens are spheroidal sub-cylindrical or cyathiform like the sponges of the cretaceous and Jura formations. They are silicified and in the polished sections, numerous radiating canals with star-like groups of spiculæ are clearly exhibited, presenting an internal structure altogether analagous to that of the more recent sponges. There are six species described, one of which, *Astylospongia præmorsa* is identified with the European *Siphonia proæmorsa* (Goldfuss). Fossil sponges are rare in all the formations below the Cretaceous and Jura, but we have some reason to believe that they here occur at the very base of the palæozoic system. In addition to the American species described by Dr. Roemer we find that another form has been discovered in the lower Silurian rocks of Kentucky for which the name *Scyphia dentata* has been proposed. (See the 2d Report of the Geo. Sur., of Kentucky, page 111.) In Canada a species closely allied to Roemer's *A. stellatim-sulcata,* oc-

* Proceed. Acad. Nat. Sci., Phila., May, 1857, p. 133.

† As we had also shown in Proceed. Acad. Nat. Sci., May, 1857, p. 133.

curs in the Trenton Limestone while two or three others have been found in the Chazy and Calciferous formations. These will be described soon in the Reports of the Geological Survey of Canada. One of the Canadian species somewhat resembles in form the *Palæotrochus* of Emmons. (See this Journal, 2d Series, vol. xxii, p. 389), and has one of the extremities covered with radiating grooves in the same manner. It seems probable therefore that *Palæotrochus* is a sponge instead of a coral. Dr. Roemer has described two new genera of Crinoids, *Lampterocrinus* and *Cytocrinus*, both of which appear to be related to *Actinocrinus*. Among the brachiopods, we find *Calceola Tennesseensis*, no doubt, identical with Prof. Saffords *C. Americana* published in this Journal in March last; the former name has the priority as Roemer has described it several years since in Bronn's Lethea Geognostica. The concluding chapter contains an interesting comparison of the Upper Silurian Fauna of Tennessee with that of the same age in Europe. All the species are well figured.

E. B.

[We have received, too late for this issue, an important paper from Prof. Safford "On the Upper Silurian beds of Western Tennessee, and Dr. Roemer's Monograph." A principal point in this paper is to indicate the fact that the fauna illustrated by Dr. R. is not the only one occurring on the 'glades.' To illustrate his subject Prof. Safford brings forward for the first time a tabular section of the order of succession and thickness of the rocks of the Upper Silurian in Tennessee. This memoir will appear in the succeeding number of this Journal.—Eds.]

III. BOTANY AND ZOOLOGY.

1. *Thesaurus Capensis, or Illustrations of the South African Flora, etc.*, by Wm. H. Harvey, M.D., F.R.S., &c.—No. 4, 1860, completes a century of plates and the first volume of this work. The plates are neatly executed and much better printed than those of the earlier numbers. The most interesting one to us is that of a Loasaceous plant, *Fissenia Capensis*, which is geographically very widely severed from all its coördinates, and has a trilocular ovary. A. G.

2. *Flora Capensis; being a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal;* by Wm. H. Harvey, M.D., F.R.S., &c., and Otto Wilhelm Sonder, Ph. D., &c., vol. I, Ranunculaceæ to Connaraceæ, Dublin, 1859–60.—An octavó volume of 546 pages, the first of the "at least five volumes" required for the completion of the Cape Flora. The second volume is in progress. Being intended for use in the Colony as well as by botanists generally, the work is written in the English language throughout. In view of this popular use, a comprehensive and excellent Introduction to Systematic Botany is prefixed, taken, with some alterations and additions, and by permission, from that in Mr. Bentham's Handbook of the British Flora; and to this is joined a set of clear and specific directions for the collection, preservation, and examination of plants. The sequence of orders adopted in the Flora is essentially that of DeCandolle. As one of the authors resides in Dublin, and the other in Hamburgh, the only course to take—and in any case the wiser course—was "to divide the work between them, each taking those Orders with which he was most familiar, and making them

out independently, without reference to his brother author;" although, to ensure uniformity of plan, the ordinal characters and general remarks are all written by Dr. Harvey, upon whom the general editorship devolves. The descriptions are pretty full, so that only about three species appear on a page. The great knowledge and ability of the distinguished authors, and their long familiarity with Cape plants, guarantee the high character of the work, as their untiring industry and perseverance gives good hope of their bringing to a worthy and timely completion the formidable task they have undertaken. Noting that Dr. Sonder has adopted Dr. Klotzsh's genus *Dianthera*, in the Capparideæ, we beg to say that there is a Linnæan genus of that name, unaccountably neglected by recent botanists (North American ones excepted), but not rightfully to be superseded. A. G.

3. *Flora of the British West Indian Islands;* by A. H. R. Grisebach, M.D., Professor of Botany in the University of Göttingen. London: Lovell Reeve. Parts 1 and 2, 1859, pp. 192, 8vo.—This is another of those Colonial Floras now fostered by the British Government; indeed this is the first strictly belonging to the series. It is written throughout in English, and wonderfully good English too, considering that the author is a German. Through abbreviations and the omission of references, it is more compact than the Flora Capensis, and will probably be comprised in one or two volumes. The work is much needed, and Dr. Grisebach is doing excellent service in clearing up the manifold confusion and obscurities of West Indian Botany, and indeed of Central American Botany generally, to which he has paid much attention. The third part of this work, completing the Polypetalæ and Apetalæ combined, is, we learn, already published.

[The third part of the West Indian Flora has just come to hand. It finishes the Poly-apetalous orders, and closes the first volume of 322 pages. The larger orders it comprises are the *Leguminosæ*, the *Myrtaceæ*, and the *Melastomaceæ*, the two latter are very thoroughly and admirably re-elaborated.]

Another Flora of this series, now printing, is that of the island of Hong Kong, by Mr. Bentham. Among the most important materials for this Flora must be reckoned the collections made in that island by Mr. Charles Wright, as Botanist of the North Pacific Expedition under the command of Captains Ringgold and Rodgers, which are liberally contributed for this purpose. The same Expedition contributes also to the Flora Capensis "upwards of five hnndrèd species of plants" from the collection of the same indefatigable botanist made whilst the vessels were detained in Simon's Bay; among which, adds Dr. Harvey, are some species not received from other collectors,—good evidence of Mr. Wright's industry and acuteness.

These qualities, and an indomitable spirit of research, are now applied to the West Indian flora; and the fruits are beginning to appear in the

4. *Plantæ Wrightianæ e Cuba Orientali*, a A. Grisebach;—a paper in the Memoirs of the American Academy of Arts and Sciences, vol. viii, new series, of which a small edition is separately issued for distribution among botanists. It contains many new and rare species, and the field is far from being exhausted. This paper is followed by

5. *Filices Wrightianæ et Fendlerianæ*, etc., cura Daniel C. Eaton, A.M., an enumeration of the Ferns of this same rich Cuban collection, along with those of Fendler's Venezuelan collection, with characters of new species, etc. The sets of Fendler's Ferns issued to subscribers are exhausted; but those of Wright are still to be had, and are to be augmented by new collections. A. G.

6. *Local Botanical Catalogues.*—These are interesting as helping to determine the geographical range of our species, and also as indicating the zeal and activity of our local botanists, perhaps never greater than now. The following, published during the year 1860, are before us:—

7. *Additions to the Flora of Wisconsin;* by T. J. Hale, of the University of Wisconsin.—The number of species and varieties added to Mr. Lapham's latest Catalogue, published in 1852, "amounts to 283, of which 112 are Mosses, Liverworts, and Lichenes." The catalogue of these is contributed by Mr. Lapham. The most notable addition is that of the rare *Sullivantia Ohionis*, before known at only one station, in the central part of Ohio, but lately detected by Mr. Lapham on the Wisconsin River.

8. *Catalogue of the Flowering Plants and Ferns of Ohio;* by J. S. Newberry, M.D. Originally prepared for the Ohio State Medical Society, but now published by the Agricultural Society, prefaced by some interesting remarks upon the influences, "physical, geological and climatic, which have determined the distribution of the species.

9. *A Catalogue of Plants found in New Bedford, Mass., and its vicinity;* by E. W. Hervey. The plants are arranged according to the season of their flowering. Nine species only come into bloom between the middle of March and the first of April,—viz., the common Chickweed, the English Groundsel, which are introduced, two Poplars, two Hazels, and an Alder, *Epigæa*, and *Draba verna*. We suspect that the latter is also an introduced plant.

10. *Catalogue of the Phænogamous and Filicoid Plants of New Castle County, Delaware, arranged according to the Natural System, with the Synonyms of Modern Authors;* by Edward Tatnall. (Published by the Wilmington Institute.)—A very full and handsome Catalogue of 112 pages, including a list of expected species, and an extended catalogue of the *Diatomaceæ* and *Desmideæ* detected in that district, by Mr. C. Febiger. The addenda comprises among other things, the *Sagittaria calycina* of Engelmann. This was known only as a Western species, viz. —in Texas, Louisiana aud Missouri. In the manuscript, communicated by Dr. Engelmann to the Botany of the Mexican Boundary Survey, he gave the "Merrimac River, Missouri," as a station of one variety of this species. In the proof-reading this was somehow changed into the better known "Merrimac River, Massachusetts." This error proves to be less serious than could have been expected, Mr. Swan having since detected a submerged form of this very distinct species at Kennebunk, Maine, not far north of the Merrimac. Mr. Tatnall has now found it in Delaware. A. G.

11. *Fungi Caroliniani Exsiccati: Fungi of Carolina illustrated by natural specimens of the Species;* by H. W. Ravenel, Corresp. Memb. Acad. Nat. Sciences, &c. Fasc. I–V. Charleston, S. C., Russell & Jones,

King st.—These fascicles are volumes, of quarto form, each containing a century of species; the specimens attached to the leaves of thick cartridge paper, with printed tickets. Each volume has an Index, and the fifth, issued last autumn, has a full index of the whole work. This induces the fear that the undertaking may not be continued farther. Much as this is to be regretted it is not surprising; for these undertakings involve a deal of labor and anxiety. The Cryptogamic *Exsiccati* of this country—as a whole perhaps unrivalled by those of any other—viz., of the *Musci* by Sullivant and Lesquereux, the *Lichenes* by Tuckermann, and the *Fungi* by Ravenel,—are all labors of love, and monuments of patience and disinterestedness; for their cost to subscribers defrays but a moiety of the cost of production. They are intended to stimulate research in these several branches of Cryptogamic Botany, and to facilitate their study. For this last purpose these *Exsiccati* are all essential, and they would be hardly less so even if proper manuals and other descriptive and illustrated works upon our lower Cryptogamia were generally obtainable. In time these desiderata will probably be supplied; but authentic specimens will always be invaluable. The former volumes of Mr. Ravenel's *Fungi* have been noticed and commended in this Journal. The fifth century is equally interesting and full. Perhaps the proof-reading of the letter-press, or the niceties of the typography have not been so heedfully attended to as could be desired; but we must not be over nice or too critical. We are truly grateful for what Mr. Ravenel has done, and hope that his strength and patience will still hold out through as many more centuries of *Fungi Caroliniani*. A. G.

12. *Uber Polyembryonie und Keimung von Cœlebogyne: ein Nachtrag zu der Abhandlung über Parthenogenesis bei Pflanzen, von* A. Braun. (Aus. Abhandl. der K. Akad. Wissenschaft. Berlin, 1859.) Berlin, 1860.—This elaborate treatise On the Multiplicity of Embryos and Germination of *Cœlebogyne*, a sequel to the Memoir on Parthenogenesis in Plants, occupies 263 quarto pages, and is illustrated by six plates. It discusses in great detail not only polyembryony, but many recondite incidental questions arising out of parthenogenesis. The principal direct, and a very curious contribution to our knowledge is, that polyembryony is common, or even general, in parthenogenesis; in other words, when embryos are produced without impregnation, they are apt to be superfluously and abnormally numerous. Thus, the seeds of *Ardisia polytoca*, figured by Prof. Braun, are stuck as full of embryos as is a pudding with plums. It would be interesting to know whether, conversely, multiplicity of embryos as it occurs in this case, and in orange seeds, where the flowers are hermaphrodite, indicates, not superfluous impregnation, but failure of impregnation,—a singular paradox. A. G.

13. *Illustrations of the Genus Carex;* by Francis Boott, M.D., Treasurer of the Linnæan Society. Part Second, Tab. 201–310. London, Wm. Pamplin, 1860, folio.—Two years ago we gave some account of the first volume of this magnificent and munificent work. We now have before us a second volume, containing one hundred and ten more plates, of an execution more uniformly excellent than before. The species illustrated are considerably less numerous than the plates, for sometimes two or three, or even four, and in two instances five folio plates are de-

voted to the various forms of one species. American Caricologists will be delighted to find so many of our own species in this volume, such as *C. Franklinii, laxa, livida, limosa, Magellanica,* (which is *C. irrigua,*—here we think the rule of priority might have been waived), *rosea, retroflexa, bromoides, glaucescens, turgescens, Elliottii, Schweinitzii, rostrata, folliculata, subulata, Shortiana, debilis, glabra* (a new species gleaned from our old fields by Dr. Kneiskern), *retrorsa, tentaculata, Halei, squarrosa-stenolepis, Novæ-Angliæ, Emmonsii, varia, Pennsylvanica, umbellata, nigremarginita, Floridana, Richardsoni, miliacea,*—not to mention several others from further north or the far northwest. We hear that even a third volume is in a forward state of preparation, which may be laid before our Caricologists by the time they have digested the ample portion now so liberally supplied,—so rich is our author in materials, so zealous in good works. "*Carice pastus acuta*" having long foraged upon the sedges of every land, and ruminated his vast stock of materials with unwearied patience and skill, long may he still flourish to produce such noble volumes as these. A. G.

14. *A Second Century of Ferns; being Figures with brief Descriptions of one hundred new, or rare, or imperfectly known species of Ferns; from various parts of the World;* by Sir WILLIAM JACKSON HOOKER, K.H., &c. London, 1860. William Pamplin. 8vo. Parts I and II, tab. 1–50.—The first Century of Ferns was published several years since; it consisted entirely of plates and descriptions taken from the well known *Icones Plantarum,* but the plates were not numbered to correspond with those of the *Icones,* and for this reason the work has not been generally quoted by writers on Ferns. The second *Century,* however, consists entirely of new matter, well selected, and its publication brings to light many new or obscure species. A new *Struthiopteris* (*S. orientalis,* Hook.) from Japan, figured at plate 4, and the imperfectly known *Camptosorus Sibiricus,* Rupr., (here reduced to *Scolopendrium,*) at plate 35, will especially interest the American botanist. The latter Fern differs from our common Walking-leaf "by the entire absence of lobes or auricles at the base of the frond." D. C. E.

15. *Species Filicum; being Descriptions of all known Ferns. Illustrated with Plates;* by Sir WILLIAM JACKSON HOOKER, K.H., &c. Parts XI and XII, or vol. iii, parts III and IV. pp. 161–291, tab. 181–210.—This portion of the work is mostly taken up by the latter part of the great genus *Asplenium,* including *Darea, Athyrium, Diplazium, Anisogonium, Hemidictyum, &c.,* of authors. *Diplazium* differs from other *Asplenia* only in the double fruit-dots, a most inconstant character. *Darea* passes into *Euasplenium* through many species having the marks of both groups; and even *Athyrium,* perhaps the best defined of all, is too uncertain to be separately retained. Such genera as *Anisogonium, Hemidictyum* and *Thamnopteris,* depending only on slight differences in venation, are of course rejected, in conformity with the plan of the whole work. Of the genus, thus consolidated, 305 species are described, besides many dubious or unknown forms, which are barely enumerated. The graceful little Fern from Florida, distributed by Dr. Chapman under the names of *Aspl. Anchorita, A. verecundum,* &c., and which in his Flora is called *Aspl. myriophyllum,* Presl., is here reduced to *Aspl. rhizo-*

phyllum, Kunze, var. *myriophyllum*. It is undoubtedly through some mistake that Milwaukee in Wisconsin is given as a station for it. *Allantodia Brunoniana*, Wall., of the East Indies, and *Actiniopteris radiata*, Link., of a wider range, follows next to *Asplenium*. The usual Index concludes the volume. The distinguished author is now arranging the Aspidioid Ferns, which, we trust, will in due time appear in the fourth volume. D. C. E.

16. *Uber einige Farngattungen;* von Dr. G. METTENIUS, Professor an der Universität zu Leipzig. Frankfort-on-Main. Heinr. Ludw. Bronner. 1857–9, 3 vols. 4to.—The first contribution (I.) contains an essay of sixteen pages on the classification of Ferns, which being in German is not accessible to the majority of those whom it would naturally interest and doubtless enlighten. The learned author carefully considers the subject of the venation of Ferns, and after studying it more deeply, perhaps, than any other Pteridologist, considers that while differences of venation are of great use in distinguishing species and sub-genera, they are too indefinite to be used as generic characters. This essay is followed by a monograph of the genus *Polypodium*, in 121 pages, in which 268 species are recognized, many of them described and illustrated by references to the numbers of distributed collections, and often by fragmentary but careful sketches of the venation, in three crowded lithographic plates. There are also given the names of a hundred or more dubious or imperfectly known species. In the index the names of not less than fifty genera of various authors are given as synonymous with parts of *Polypodium*. The species are classified mainly according to the venation and the shape of the fronds; and the whole arrangement is so simple, and yet so comprehensive, that, after a little studying of the meaning and application of the words used to distinguish sub-generic groups, one has but little difficulty in tracing an unknown species to its appropriate place in the vast genus.

The second part (pp. 158, tab. 4,) contains (II.) a monograph of *Plagiogyria*, a new genus of six species, (since reduced to *Lomaria* by Hooker,) (III.) a notice and figure of *Pteris scalaris*, Moritz, from Venezuela, showing a double involucre, similar to that known to exist in *Pt. aquilina* and its allies, and (IV.) an able monograph of *Phegopteris* and *Aspidium*, treating these genera in the same way as *Polypodium* in the first article. Of *Aspidium* there are given forty-seven generic synonyms, excluding such universally adopted genera as *Asplenium*, *Polypodium*, *Woodsia*, &c., to which some species have been incorrectly referred. The admitted species number two hundred and thirty, and there are perhaps half as many more doubtful ones.

The third part (pp. 210, tab 6,) treats in a similar way of (V.) *Cheilanthes*, and (VI.) *Asplenium*, two hundred and forty-nine species of the latter genus being recognized.

In this series of useful and comprehensive treatises "on certain Fern-genera," Professor Mettenius has followed out logically and carefully the principles he laid down at the beginning, and consequently, whatever views of the importance of venation, etc., botanists may have, all must concede to his writings a consistency as well as ability not often met with. In the identification of species Professor Mettenius has to aid him the large and

valuable herbarium of Kunze, his predecessor at Leipzic, and has been intrusted with numerous collections from various herbaria, embracing the original specimens of various authors, as Swartz, Desvaux, Presl, &c. To these may be added many of the Ferns collected by Wilkes' Exploring Expedition, so that he will be able to identify in his future works the species described by Brackenridge in the report on the Ferns of that Expedition. D. C. E.

17. *Filices Horti Botanici Lipsiensis;* G. Mettenius. Lips., 1856. fol. pp. 135, tab. 30.—In this work, which preceded those above-mentioned, Professor Mettenius has had an opportunity of applying his principles of classification to the whole class of Vascular Cryptogamia. *Phegopteris*, though without an indusium, is retained as a genus among the *Aspidieæ* because the stipe is continuous with the rhizoma, and not articulated as in *Polypodieæ*, and because the habit, which has nothing in common with *Polypodium* so closely resembles that of many *Aspidia*, that botanists are continually making interchanges between the two genera, as the species become better known. *Hypolepis* is regarded as *Phegopteris* with reflexed lobes, and is therefore put next to it. The suppression of the old Linnæan genus *Hemionitis* will be regretted, but its venation is all it has to distinguish it from *Gymnogramme*, to which it is here reduced. The *Acrosticheæ* of course give Professor Mettenius some trouble, and it is doubtful if he can eventually limit them to the five genera recognized in this work.

The book is beautifully printed, and the plates are of singular accuracy and distinctness. D. C. E.

Zoological Notices.—

18. *On the genus Peasia.*—In the Proceedings of the Zoological Society of London for 1860, page 37, plate 70, Mr. Wm. H. Pease of Honolulu has published descriptions and colored figures of five species of Planariidæ from the Sandwich Islands, supposed to form a new genus. Of these species, which are pretty well represented on the plate, the first is a *Stylochus*, the second and fifth are *Prosthiostoma*, the third a *Physanozoum*, and the fourth an *Eurylepta*. This kind of progress can scarcely benefit science. As well might one take a *Strombus*, a *Conus*, a *Cypræa* and a *Terebra*, and found upon them a new genus of shells! W. S.

19. *On the genus Bipaliura;* by Wm. Stimpson.—During the visit of the North Pacific Expedition to Hong Kong in 1854, my attention was called, by Dr. Bowring, to some remarkable vermiform animals which he had observed creeping among damp dead leaves in his garden, and which he called "ground leeches." One of these we fortunately secured, which was found upon examination to possess the following characters. The body was linear, nearly two feet in length when fully extended, and scarcely more than an eighth of an inch in breadth. The surface was slimy, like that of a slug, and of a greyish color, with two or three longitudinal black stripes above. The head was lunate, transverse to the body, with the convexity in front, and the auricles projecting laterally to a distance equalling about half the width of the body. Upon the upper surface of the head, were scattered some minute black specks, which were undoubtedly imperfect eyes (ocelli). On the inferior surface of the body there were two small apertures in the median line, the anterior one of which, at the middle of the body, was the mouth.

The worm therefore belonged to the order Turbellaria and to the tribe of Planarians, it is undoubtedly one of the most remarkable forms, of a very distinct and peculiar genus. Upon a recent examination of the literary history of the group I find that species of the genus have been seen and described by several other observers. The following is its history.

Many years ago (1835) Dr. T. E. Gray in his "Zoological Miscellany" first described one of these animals under the name of *Planaria lunata*, from Bengal, (Zool. Misc. p. 5). The description is short, but sufficient to show unmistakably the place of the species in the genus under consideration. This description has been overlooked by all subsequent authors, and even Dr. Gray himself appears to have forgotten it, although he has undoubted priority.

In 1842 Dr. Cantor in a paper on the fauna and flora of Chusan (Ann. Mag. Nat. Hist., ix, 277) says, "Among the annelides occurs a remarkable form with the anterior part drawn out to the sides like the head of *Zygæna*. He also speaks of two other species known to him, one from Bengal. The latter is probably *Pl. lunata*.

I can find no further published mention of such forms, even in the "Systema Helminthura" of Diesing, 1851, who overlooks Gray's description,—until the appearance of my Conspectus of the Turbellaria Dendrocœla in the Proceedings of the Philadelphia Academy of Natural Sciences for February, 1857, where the genus is described under the name of *Bipalium*, which name was suggested by the resemblance of the animal, in the shape of its head, etc, to a double mattock, or pick-axe. It was placed in the family *Geoplanidæ* with the following diagnosis.

"Corpus lineare, depressiusculum. Caput discretum, lunatum, transversum; auriculis sat longis, retrorsum tendentibus. Ocelli numerosi, minuti, in capite plerumque in ejus marginibus dispositi. Os centrale vel post-centrale. Apertura genitalis inter os et extremitatem posteriorem, sepius ad dimidiam distantiæ sita."

Four species were described, all from the Japanese islands. The original species observed in China was not found named in the Synopsis, as the specimens of that species were unfortunately lost.

In 1859 the genus was renamed by Dr. Schmarda in his "Neue Wirbellose Thiere." He calls it Sphyrocephalus and gives a colored figure, and an anatomical description.

Still more recently, in the Annals and Magazine of Natural History, it has been again named by Dr. E. Percival Wright, who calls it *Dunlopea*, and describes three species. Dr. Wright, however, having only preserved specimens to examine, has misunderstood its character somewhat. He states that there are no ocelli, and has failed to perceive the genital opening.

Both Schmarda and Wright have overlooked previous labors, so that the genus now rejoices in three distinct appellations, all given within four years. Of these *Bipalium* is the earliest. Eight species are now known.

20. *The Museum of Comparative Zoölogy* in Cambridge, Mass., was dedicated with appropriate ceremonies and addresses, to the service of Science and the Commonwealth, on the 13th of November, in the presence of a large concourse of invited guests.

IV. ASTRONOMY AND METEOROLOGY.

1. *Three more Asteroids.*—Three more of the large group of little planets between Mars and Jupiter have been discovered since Sept. 1, 1860. In consequence of a prior discovery, the one detected by Mr. Ferguson at Washington, D. C., September, 1860, and numbered 59, has been advanced to No. 60. It is proposed to call it *Titania.*

The numbering of the asteroids is in danger of becoming confused on any plan yet devised. It is scarcely possible to say what is the order of discovery in absolute time, for a planet is sometimes seen several days before its true character is determined. The exact order of numbering is of little importance, but it is desirable that the numbers once adopted should not be changed without urgent reason. The number of the second Daphne is not even yet well settled.

The 59th asteroid, (of 10th magnitude) was discovered by M. Chacornac at Paris, Sept. 12, 1860.

The 61st, named *Danäe*, (of 10–11th magnitude) was first seen Sept. 9, 1860, by Goldschmidt, but on account of his illness it was lost for several days.

The 62d named *Erato* (of 11th magnitude) was discovered by Drs. Förster and Lesser at Berlin, Sept. 14, 1860.

2. *New Comet.*—A telescopic comet was discovered October 23, 1860, by M. Temple at Marseilles. Its place, Oct. 23, 16^h 30^m m. t. Mars., was R. A. 10^h 4^m 38^s, N. decl. 28° 27′.

3. *Further observations on the Shooting Stars of August* 9–10, 1860.

(1.) *At Chicago, Ill.*, by Mr. FRANCIS BRADLEY and others.

On the evening of August 8, 1860, Mr. B. watching alone from 10^h 30^m to midnight, saw *seven* shooting stars, but the sky was much clouded.

On the night of Aug. 9 he observed alone from 11^h 30^m P. M. to 1^h A. M. of the 10th, *fifty-seven* shooting stars, 41 of which he counted during the last hour, the sky being throughout the hour much encumbered by small cumulous clouds.

On the night of Aug. 10, Mr. Bradley was assisted by Messrs. E. P. Marsh, Wm. Dickinson, Henry E. Chesbrough, and I. H. Scupham. Between 11^h P. M. of the 10th and 2^h A. M. of the 11th, they observed 384 different shooting stars, distributed as follows, viz:

11^h to 12^h		12^h to 1^h		1^h to 2^h	
N.E.	23	N.E.	23	NE.	15
E.	40	E.	31	E.	19
S.	26	S.	35	S.	15
S.W.	32	S.W.	35	S.W.	24
N.W.	22	N.W.	22	N.W.	22
	143		146		95

During the last hour clouds appeared and increased so much that by 2 o'clock the sky was half covered, and the watch was therefore given up. After midnight the moon also interfered to some extent. Of the whole number of meteors seen about 30 were not conformable to the usual radiant, which for the night of the 10th–11th was a circle about two degrees in diameter, whose centre was in A.R. 2^h 8^m, N. P.D. 29°.

The Aurora Borealis was visible Aug. 8, 10, 12, 17, being uncommonly fine on the night of the 10th–11th.

(2.) *Paris, France*, by M. Coulvier-Gravier.—This indefatigable observer has published in the Comptes Rendus of the French Academy (li, 263), a table giving the results of his observations from July 13 to Aug. 12, 1860. The mean hourly number at midnight of shooting stars Aug. 9 he finds to be 62, Aug. 10th, 54, or about ten times as large as he finds it in the middle of July.

(3.) *Rome, Italy*, by M. Secchi.—The shooting stars observed early in the month gave a decisive maximum on the 10th of August, viz.,

9th, from 9^h to 10^h 30^m P.M. 50 shooting stars, of which 8 were very brilliant.
10th, " 8^h 45^m " 10^h 30^m " 124 " " " 25 " " "
11th, " 8^h 30^m " 9^h 30^m " 25 " " " 5 " " "

The observations at Chicago of the 10th–11th, taken with those at New Haven of the night before, show that the August meteoric display continues to agree closely in all its characteristics with the phenomenon as observed more than twenty years ago. The number of shooting stars at this epoch is at least six times the common average, increases from evening twilight to morning dawn, is about equal on the night of the 9th and the night of the 10th, and the apparent direction of nearly all is from the vicinity of the constellation Perseus. E. C. Herrick.

4. *Shooting Stars in November*, 1860.—For a few years before and after the ever-memorable meteoric showers of November 13th, 1832, and November 13, 1833, shooting stars were unusually abundant on that calendar day. The cycle of this phenomenon being apparently about thirty-three years, there is reason to hope for its recurrence on a large scale in 1865, 1866, or 1867, and we may expect now to see some traces of its coming. At New Haven this year, the sky was unfortunately overcast during the nights of Nov. 11–12 and 12–13. The following statements show, however, that about this period the number of shooting stars was plainly above the average. The observations from Maryland indicate that, notwithstanding this is leap-year, the night of the 13th–14th is the most fertile. This confirms the supposition that the meteoric shower of November is slowly advancing into the year. If, as is highly probable, this display is the direct successor of the like displays of Oct. 26, 1202 and Oct. 30, 1366, (this Jour. [1], xl, 364,) the motion of the node of the zone or ring which furnishes these shooting stars is at the rate of three or four days in a century. E. C. H.

(1.) *Near Cape Hatteras*, lat. 35° N., long. 75°, Nov. 7, 1860.—Dr. Bronson, of New York, Prof. C. U. Shepard and daughter, counted *forty-six* meteors in two hours, from 7^h to 9^h P. M. They were mostly from a point to the N.E. of the zenith. The mate of the steamer Columbia said he saw an equal number the previous night when they were North of Cape Hatteras. The night of the 8th nothing unusual was seen.

(2.) *New Haven, Conn.*—Wedn. morning, Nov. 14, 1860. Sky very clear and no moon. Prof. H. A. Newton, watching alone, from 3^h 15^m to 4^h 15^m and looking to the S.E. observed *twenty-one* shooting stars. His view was limited by high buildings and other obstructions, and embraced about one fourth of the hemisphere, from the zenith down to an altitude of about 30°; the constellation Leo being in the centre of the field of view. Of the meteors seen less than a fourth part traced back would intersect in the sickle in Leo, a larger number would intersect near the zenith. None were remarkable for size or for train.

Nov. 15. Sky very clear. Prof. H. A. Newton watching as before, during 45 minutes from $3^h\ 40^m$ to $4^h\ 25^m$, observed *fifteen* shooting stars, having the same general characteristics as those of the morning previous.

(3.) *New York City.*—November 14. Prof. A. C. Twining watched for shooting stars during one hour, from 3 A. M. to 4 A. M. His position was at an open area commanding a good view of the S. E. quarter of the sky. The atmosphere was uncommonly clear, but the glare of the street lamps doubtless interfered with the visibility of very faint meteors. During the first fifteen minutes by estimate, he observed ten meteors, eight of which had paths conformable to the radiant point of 1833, and two of which had paths not conformable. For the next half hour not a meteor was seen. At $3^h\ 45^m$ the largest of all appeared, with a long, conformable and brilliant path. After this till 4^h three non-conformable were seen, two of which shot from near the zenith. The observed number during the hour, was therefore 14, nine conformable and five unconformable. In conclusion, he remarks:—"Compared with the similar phenomena in the years following the great meteoric shower of 1833, the meteors of the present year (except the single one at $3^h\ 45^m$) were but faintly developed. Yet it was impossible not to perceive in the whole taken together at least a *symptomatic* return of the periodical display. The morning of the 13th may have been richer in the phenomena, but it was not favorable for observation."

(4.) *Montgomery Co., Md.*—Very full observations were made during the two entire nights of Nov. 12 and 13, (both clear,) under the direction of Mr. Francis Miller, principally by the students of the Stanmore School, in Montgomery Co., Md. The following table shows the number of shooting stars observed during the different hours.

			N.	S.	E.	W.	
Nov. 12,	$6\frac{1}{2}^h$ P. M.	to 7^h P. M.	0	1	3	0	4
	7	" 8	5	8	5	3	21
	8	" 9	9	12	6	3	30
	9	" 10	11	9	13	5	38
	10	" 11	8	12	14	4	38
	11	" 12	12	14	13	6	45
				N.W.	E.	S.W.	
13,	0 A. M.	" 1 A. M.		13	20	9	42
	1	" 2		10	13	6	29
	2	" 3		25	30	13	68
	3	" 4		19	23	18	60
	4	" 5		16	20	12	48
							423
			N.	S.	E.	W.	
13,	$6\frac{1}{2}$ P. M.	" 7 P. M.	4	8	8	6	21
	7	" 8	13	6	14	9	42
	8	" 9	8	7	13	2	30
	9	" 10	6	5	12	7	30
	10	" 11	10	8	19	7	44
	11	" 12	7	6	12	13	38
14,	0 A. M.	" 1 A. M.	11	9	13	13	46
	1	" 2	25	18	20	20	83
	2	" 3	8	24	20	10	62
	3	" 4	7	17	12	10	46
	4	" 5	16	16	11	15	58
			115	119	154	112	500

For the purpose of comparison, Mr. Miller with some of his scholars observed on the night of December 12, 1860, and during 3 hours and 40 minutes ending at midnight, they saw 180 different shooting stars, distributed as follows, viz:

	N.	S.	E.	W.	
$8^h 20^m$ to 9^h P. M.	13	8	5	4	30
9 " 10	13	8	4	9	34
10 " 11	10	30	7	9	56
11 " 12	16	15	21	8	60

It should be remembered that the season from December 6th onward a few days is one in which shooting stars are sometimes unusually numerous. (See this Jour. [1], xxxv, 361.)

(5.) *Bloomington, Ind.*—In a letter to the Editors of this Journal, Prof. Daniel Kirkwood of the Indiana State University writes as follows:

"Assisted by several members of the Senior Class, I kept an incessant watch for meteors during six hours on the night of the 12th inst. (November, 1860.) The number of observers was at no time less than five, so that the entire hemisphere was kept in view. The first to notice the appearance of a meteor announced it aloud, that it might not be counted more than once. The whole number seen was 381, as follows:

From 10^h to 11^h P. M. - - - - -	45
11 " 12 - - - - - -	66
12 " 1 - - - - - -	68
1 " 2 - - - - - -	66
2 " 3 - - - - - -	90
3 " 4 - - - - - -	46
	381

About one half of those seen after one o'clock appeared to diverge from the usual point in Leo."

5. *Narrative of the American Expedition to N. W. British America, to observe the total Solar Eclipse of July 18th*, 1860; written by Wm. Ferrel, and communicated by Capt. C. H. Davis, U. S. N., Superintendent of the Nautical Almanac.—The party consisted of two assistants sent from the Nautical Almanac Office, and of Mr. S. H. Scudder, of Boston, who was sent by the Museum of Comparative Zoology to make collections in Natural History, and who was also engaged to assist in making observations on the day of the eclipse. Leaving Boston and Cambridge at different times, the members of the party met at St. Paul on the 14th of June. Engaging a passage here on Mr. Burbank's line of stages and steamboat for Fort Garry, on the Red river of the north, they left on the morning of the 16th, and after traveling four days in a northwestern direction over the beautiful and fertile, though almost entirely uninhabited, plains of Minnesota, they arrived at Georgetown, on Red river. The party remained here one day waiting for the arrival of the Anson Northrop, a boat which runs on the Red river between this place and Fort Garry, and while here, enjoyed the hospitality and kind assistance of A. H. Murray, Esqr., Chief Trader of the Hon. Hudson's Bay Company, who seemed to be much interested in science in general, and in the success of the expedition. After following the very tortuous course of Red river about 400 miles, the party arrived at Fort Garry, in British America, on the 25th of June. Calling here upon Gov. Wm.

Mactavish, and presenting him a letter received from the late Sir George Simpson granting permission to enter the territory, the members of the party were treated by him very courteously, and received his efficient and kind advice and assistance in obtaining an outfit and supplies for their canoe voyage through lake Winnipeg and up the Saskatchewan river. He made arrangements to transport them and their baggage on a barge to the Stone Fort about twenty miles below Fort Garry, and granted them the use of a large North canoe there without charge, and also gave them a letter to Mr. Lillie in charge there, requesting him to aid them in obtaining a suitable crew, and every thing else necessary for the expedition. An old and experienced guide and five paddlers were obtained, mostly aboriginal natives of the country, and the party was ready to leave on the 28th. The remainder of the route of the expedition was down the Red river about twenty miles to the lake, through the lake to the mouth of the Saskatchewan, and then up the Saskatchewan to Cumberland House, in all about 550 miles. The country after leaving the Red river settlement, is a desolate and uninhabited wilderness, abounding in marshes and tamarac swamps, with a few limestone bluffs along the western coast of the lake. A few encampments of migratory Indians, obtaining a miserable subsistence from fishing, were the only inhabitants seen. A voyage on lake Winnipeg in a frail canoe of birch bark, when it is stormy, is considered dangerous, especially the making of traverses of ten or twelve miles, of which there are a great many, and as the party had an unusually stormy time, and a rather frail canoe heavily loaded, it was very much detained on the voyage by the wind and waves. The party was fourteen days in going the length of the lake from Red river to the mouth of the Saskatchewan, and during the whole time it was enabled to proceed only one entire day without interruption, and was obliged to spend three consecutive days and nights on a small island in the lake on account of a long continued and violent storm. On arriving at the mouth of the Saskatchewan it was found that the river was never known to be higher, and that the ascent over the rapids and up the current the whole distance to Cumberland House would be unusually difficult only a little more than four days were left; yet the party still hoped to be able to accomplish it against the time of the eclipse. The crew labored very hard in ascending the rapids, being obliged at some places to drag the canoe along close by the shore by means of ropes, taking first only one half of the baggage and then returning for the other half, and at other places to exert the utmost of their strength with long poles in getting it past high and steep bluffs and rocks projecting into the current, so that two days were spent in making the Grand Portage, and ascending some eight or ten miles of rapids near the mouth of the river. The party now despaired of being able to reach Cumberland House in time for the eclipse, but still had hopes of being able to get within the limits of total darkness. After passing through Cedar lake, the whole country for nearly a hundred miles was overflowed by the water of the river, so that the party could find no dry spot to stop upon but were obliged to cook with a fire made amongst the roots of large floating trees, and eat and sleep in the canoe. In order to get, if possible, within the limits of total darkness to ob-

serve the eclipse, the crew were persuaded to paddle up the river for thirty-six hours without stopping for sleep or rest, but late in the evening preceding the eclipse the party had been able to get only to the mouth of Moose river, a few miles only within the limits of total darkness. It was now very cloudy and rainy, and the strength of the crew was exhausted so that the party could do no better than stop and make preparations for observing the eclipse from this point, if by chance it should be visible next morning. It was, however, still raining in the morning and continued very cloudy until after the beginning of the eclipse, so that it could not be observed. A few glimpses of the eclipse were caught nevertheless, before it became total, but for some time immediately before and after the time of totality it was completely obscured by the clouds, so that no observations of the physical phenomena which always occur at that time, could be made. Just before the time of the total eclipse the clouds suddenly became very dark, which any one not acquainted with the cause might have attributed to the sudden gathering and thickening of the clouds before a heavy shower of rain. The darkness was at no time so great that the title page of the Nautical Almanac could not be read with facility. The instant of the end of the total eclipse was determined by the observation of a sudden change in the intensity of the light, although the disc of the sun was not seen for some time afterward. There were two strata of clouds, an upper stratum with openings through which the disc of the sun was at times seen, and a lower stratum of thin scudding clouds, which served as a screen during the greater part of the time, for observing the eclipse when it was seen through the openings in the stratum above.

The following are the results of the observations made with the telescope and sextant:

Latitude of station, - - -	53°	45′	46″
Chronometer fast of local time, - -	1^h	54^m	14·1
Ending of total eclipse, - - -	18	20	53·9
Last contact, - - - - - -	19	21	9·1
Last contact with large spot, - -	19	7	29·1

The party was furnished with Professor Hind's Report, and the accompanying maps, of the Assinaboine and Saskatchewan exploring expedition, which were of great advantage in enabling it to determine its rate of progress, the distance and locality of good boat harbors, &c., by a reference to the map in which all the principal bays, islands, capes, harbors, dangerous boulders, &c., seem to be accurately delineated, as well as described in the report. They were especially useful in determining the point on the river of the southern limit of total darkness of the eclipse.

In returning, the party was again much detained by stormy weather, being obliged to stop four days and nights on point Kichinashi, and was again fourteen days in traversing the lake. On arriving at Fort Garry, on the 8th of August, it was found that the Anson Northrop had stopped running on account of low water and was laid up for the season, so that the party was detained there two weeks without any means of getting away or writing home. Finally an arrangement was made with Mr. M'Kinney, who was coming through to St. Paul with

a train of ox wagons and carts for merchandize, to take the party and its baggage with him: hence its long delay. Twenty-two days were occupied in crossing the plains from Fort Garry to St. Paul, by way of Pembina on Red river and Crow Wing on the Mississippi, 130 miles above St. Paul, so that the party were not able to get back to Cambridge before the 20th of September.

V. BOOK NOTICES.

1. *On the Impurities of Commercial Zinc, with Special Reference to the Residue insoluble in Dilute Acids, to Sulphur, and to Arsenic;* by Charles W. Eliot and Frank H. Storer. pp. 40, 4to. (From the Memoirs of the American Academy of Arts and Sciences, [N. S.,] vol. viii, p. 57).*

In the elaborate memoir before us the authors have given a detailed account of their investigation of the impurities of commercial zinc and of their endeavors to obtain precise and definite knowledge upon the subject, with which to replace the loose, inaccurate and often contradictory statements which are current in chemical literature.

Having in the first place given a very complete synopsis of the opinions which had previously been recorded, they proceed at once to describe the experiments made by themselves. In order that their results should be as general as possible they examined authentic specimens of all the commercial zincs which they were able to procure: viz., 1. *Silesian*, 2. *Vieille Montagne*, 3. *New Jersey*, 4. *Pennsylvanian*, (from Penn. and Lehigh Zinc Works at Bethlehem,) 5. *Vieille Montagne*, (such as is used at the U. S. Mint,) 6. a sample labelled *Zinc pur*, from Rousseau Frères dealers in pure chemicals at Paris, 7. of unknown origin obtained in Berlin, (Prussia),—8, 9, 10 and 11, samples of "*English* Zinc," obtained from different works in Wales.

"A qualitative examination of the residues left by these zincs when treated with dilute acids, showed that they consisted chiefly of *metallic lead*. It will appear in the sequel, that lead is the chief impurity of commercial zinc, and that the carbon, tin, copper, iron, arsenic, and other impurities found in it by previous observers, occur either in very minute quantities, or rarely, and doubtless accidentally."

The amount of lead in each of the zincs above specified was determined quantitatively with great care. The results are as follows:†

Name of Zinc.	Amount of lead in per cent.
Silesian,	1·46
Vieille Montagne,	0·292
New Jersey,	0·079
Pennsylvania,	0·000‡
Mint,	0·494
Rousseau Frères,	0·106
Berlin,	1·297

* Communicated to the Academy, May, 29th, 1860.

† For the methods of analysis followed and precautions taken, as well as for numerous other interesting details which lack of space compels us to omit, the reader is referred to the original memoir.—Eds.

‡ This zinc leaves no appreciable residue when dissolved in dilute acid.

Name of Zinc.		Amount of lead in per cent.
English	from Wrexham,	1·192
	" Mines Royal (Neath),	0·823
	" Dillwyn & Co. (Swansea),	1·661
	" Messrs. Vivian, (")	1·516

Minute traces of *cadmium* and of *tin* were observed in several of the samples of zinc. In no case however could the sum of both these metals have amounted to one twenty-fifth of one per cent,—excepting the New Jersey Zinc which gave decided indications of tin.

No *copper* could be detected in any sample of zinc excepting that from New Jersey which contained 0·1298 per cent of this metal.

That *iron* is usually present in commercial zinc—in quantity generally less than 0·2 per cent—being derived from the moulds in which the zinc is cast, has been demonstrated by previous observers.*

Messrs. Eliot and Storer have therefore deemed it unnecessary to occupy themselves further with this impurity. They have nevertheless determined the amount of iron in several of their specimens of zinc. That from New Jersey contained 0·2088 per cent of iron.

In regard to nickel, cobalt, manganese, etc., which have been said to occur at times in zinc, the authors remark that, "the occurrence of these metals has been denied just as often as it has been asserted, but it is of course impossible to assert the universal negative, that these metals are never to be found in any spelter. * * * * Thus much may be safely asserted, however, that if nickel, cobalt, and manganese are ever to be found in commercial zinc, they occur there accidentally, exceptionally, abnormally, and in quantities hardly to be appreciated, and utterly insignificant."

"*Carbon.*—With reference to carbon as an impurity of zinc, we have attempted to determine this single point,—Does it occur in the residue insoluble in dilute acids, as has been generally believed, but never to our knowledge proved? One fact alone renders the occurrence of carbon, or of any other non-metallic substance, in this residue extremely improbable. We have observed that the residues from the Silesian, New Jersey, Rousseau Frères, Berlin, and Mint zincs are completely dissolved in perchlorid of iron, acidulated with chlorhydric acid. If carbon or silica were present in any appreciable quantity, complete solution of the residue in this reagent could not be expected. In testing the residues from our various spelters for carbon, we adopted the following process.

"From thirty to forty grammes of the zinc to be tested were dissolved in pure dilute chlorhydric acid, the black residue thoroughly washed with hot water, and, dried at a heat much below one hundred degrees (C.). The dry, grayish powder was then ground up with fused chromate of lead, and the mixture was introduced into a small bulb, blown in a tube whose diameter was not quite a centimetre. At a short distance from the bulb, this tube was drawn down to a diameter of one or two millimetres, and the extremity of the fine tube placed under lime-water in a small test-glass. The bulb was heated till the chromate of lead was fused, and if any carbon had been present in the residue, the evolved gas would have caused a cloudiness or precipitation of carbonate of lime in the lime-water. In this manner we first tested our chromate of lead by itself, and found no cloud or precipitate in the lime-water. We next inserted the smallest possible particle of carbon into the bulb with a little chromate of lead, and obtained a large distinct cloud of carbonate of lime in the lime-water in the test-glass, and in the capillary tube which delivered the gas. Having thus proved the purity of the reagent employed, and the extreme delicacy of the test, we tested in succession the residues from Silesian, Vieille Montagne, and Ber-

* Specially by Karsten in Karsten u. Dechen's *Archiv f. Mineralogie*, xvi, 623; also Dingler's *Polyt. Journ.*, lxxxvi, 193.

lin zincs, and from the zinc of Rousseau Frères. As precisely the same result was obtained with each of these zincs, it may be stated once for all.

"On heating the mixture of residue and chromate of lead till the chromate fused there appeared in each case a very slight deposit on the upper surface of the lime-water column in the fine tube. This deposit could not have been smaller and yet been visible; it was incomparably less than that produced by the atom of carbon which was purposely introduced into a similar tube, and was undoubtedly caused by the slight dust which collected on the residues during the processes of washing and drying, and which no possible precautions could entirely avoid. It is obvious from these experiments, that the often repeated statement, that the insoluble residue from zinc treated with dilute acids is carbon, rests on no adequate foundations, and that carbon is not an invariable constituent of crude zinc, as it is of iron. But on the other hand it is impossible to assert that carbon does not sometimes occur in commercial zinc as an accidental and wholly abnormal impurity. Thus in the specimen of New Jersey zinc which we examined, there were certain small cavities lined with black, as if a bubble of some carbonaceous gas had been decomposed within them, and the residue from this zinc, when tested as above described for carbon, produced a distinct cloudiness in the lime-water, which was sufficient evidence of the presence of a trace of carbon in this spelter; but the amount of this impurity was infinitesimal, and not at all to be compared in quantity with the lead and other metallic admixtures of which the residue mainly consisted. The presence of a little copper in this zinc may perhaps be connected with the occurrence of this trace of carbon. The residues from three of the English spelters also gave distinct reactions for carbonic acid in the lime-water; but, judging from the exceedingly small cloud of carbonate of lime produced, the amount of carbon in these zincs is even less considerable than that detected in the New Jersey zinc. The other English zinc (that from the works of Messrs. Vivian) yielded but the merest trace of carbonate of lime,—a little larger deposit, perhaps, than that obtained from the Silesian, Vieille Montagne, and other zincs first experimented upon, but not more than may easily have been derived from the invisible dust which undoubtedly collected on the residue. From none of these zincs could we obtain nearly as much carbonate of lime in the test-glass as we got from the smallest possible atom of carbon heated with chromate of lead; and it is quite clear that there is never anything more than an infinitesimal amount of carbon in the considerable residue which remains when thirty or forty grammes of commercial zinc are dissolved in dilute acids.

"Against the common opinion that carbon is one of the principal impurities of zinc, we would refer to the previously quoted statement of Wackenroder, who considered carbon only an accidental and mechanical impurity, and to the exact experiments of Karsten, who endeavored to determine the carbon in Silesian zinc by decomposing chlorid of silver and chlorid of copper by zinc, but 'could find no trace of carbon in either the hard or the soft kinds of zinc.'*

"*Sulphur.*—It has been frequently stated that sulphur is a common impurity of zinc, and that it even occurs in the insoluble residue in combination with lead. We first tested the insoluble residue from Silesian zinc for sulphur, by dissolving about 30 grammes of the zinc in pure chlorhydric acid, separating the black residue, and dissolving it in pure nitric acid. It dissolved without any appreciable residue (another evidence of the non-existence of tin in this spelter), and the diluted solution gave no precipitate whatever with nitrate of baryta. With 40 grammes of Vieille Montagne zinc, we obtained precisely the same result. The Pennsylvanian zinc leaves no residue when treated with dilute acids, and is therefore free from lead, and certainly contains no carbon or sulphur which manifest themselves as an insoluble residue. The New Jersey zinc gave an exceptional result. The blackish residue, from 32 grammes of this zinc, could not be completely dissolved in boiling nitric acid. The partial solution gave no precipitate with nitrate of baryta; the undissolved portion was fused before the blowpipe with carbonate of soda free from sulphur, and gave a distinct reaction, first for sulphur, and secondly for tin. The presence of tin in this spelter has already been demonstrated, and a minute trace of sulphur must also be counted among its impurities.

* Archiv f. Mineralogie, Karsten u. Dechen, 1842, xvi, 607. Karsten also says: "I have cemented sheet zinc with coal for many days, and then melted it; but in the resulting mass of zinc I have found no trace of carbon." Ibid., 608.

"In addition to this negative evidence, that no precipitation is produced by barium salts in the diluted nitric acid solution of the residues from the various zincs, we would adduce positive experiments to show that any compound of sulphur with a metal, which might be present in the zinc, would, in all probability, be decomposed in presence of an excess of zinc and free acid.

"Wackenroder,* in the memoir already cited, distinctly states that the black residue from zinc is sulphid of lead,—a statement at first sight sufficiently plausible, but really inconsistent with the facts of the case. When precipitated sulphid of lead is mixed with a large excess of granulated zinc (Silesian, Vieille Montagne, or Pennsylvanian), and treated with moderately dilute sulphuric or chlorhydric acid, the black sulphid soon entirely disappears, while torrents of sulphuretted hydrogen are evolved. If, after all the zinc has been completely dissolved, the insoluble residue is fused before the blowpipe with carbonate of soda free from sulphuric acid, the mass thus obtained will not blacken silver.

"If powdered galena be substituted for precipitated sulphid of lead, the same effects will be produced, though much more slowly. The sulphid of lead, therefore, suffers complete decomposition in presence of an excess of zinc and free acid, and it is of course absolutely impossible that this substance should be found in the insoluble residue.†

"The presence of sulphur in the insoluble residue from zinc is, without doubt, very rare; but it is also an unquestionable fact, that a certain amount of sulphuretted hydrogen gas is generated whenever commercial zinc is treated with dilute acids. This phenomenon has been often observed. Thus Blancard‡ remarks, 'that the sulphur often contained in commercial zinc may be shown by bringing paper wet with acetate of lead in contact with the gas developed therefrom.' Fordos and Gélis§ say, that 'the formation of this gas (sulphuretted hydrogen) can only be attributed to the partial reduction of the sulphuric acid by the nascent hydrogen.' Subsequently Jacquelain,‖ doubting this supposed reduction of sulphuric acid, attributes the production of sulphuretted hydrogen to the presence of sulphurous acid or other compounds of sulphur, with which the sulphuric acid is contaminated. Every specimen of zinc in our possession develops sulphuretted hydrogen when treated with dilute sulphuric or chlorhydric acid, as may be manifested by placing a slip of paper moistened with alkaline acetate of lead in the neck of the flask which contains the zinc and acid. But the question recurs, What is the source of the sulphur which is necessary for the generation of this gas? Is it contained in the zinc, or is it derived from the acids used in the experiment? To obtain a satisfactory solution of this problem, it is necessary to use an acid which does not contain sulphur in any form. Sulphuric acid will not answer the purposes we have in view in this experiment; for though it is undoubtedly possible to prepare sulphuric acid free from sulphurous acid, yet the doubt would still remain concerning the reduction of the sulphuric acid by the hydrogen,—a reduction not impossible at certain temperatures and in certain states of concentration. In testing for a minute trace of sulphur in zinc, it is evidently undesirable to employ a reagent which contains sulphur, in however stable a combination. Sulphuric acid being then excluded, will chlorhydric acid answer the purpose? It is easy to prepare chlorhydric acid which gives no precipitate with baryta salts, but it is very difficult to prepare this acid from common salt and sulphuric acid, so that, while containing no chlorine, it shall be absolutely free from sulphurous acid, or some lower compounds of sul-

* *Ann. der Pharm.*, 1834, x, 53.

† We have observed that the sulphids of tin and copper are also decomposed when mixed with an excess of zinc and dilute acid. The sulphid of copper was rapidly decomposed, and the residue, after all the zinc had been dissolved, yielded only a very uncertain trace of sulphur before the blowpipe. Precipitated bisulphid of tin was decomposed much less readily, and when all the zinc had disappeared, the residue gave indications of sulphur before the blowpipe. Although this might have arisen from some impurity in the tinfoil from which the sulphid was prepared, yet it was evident that the decomposition of the sulphid of tin is effected with much greater difficulty than that of the sulphids of lead and copper.

‡ Jour. de Pharmacie, 1841, p. 543, in Dingler's Polyt. Jour. 1841, lxxxii, 425.

§ Comptes Rendus, 1841, xiii, 437.

‖ Ann. de Ch. et Phys., 1843, [3,] vii, 189.

phur. Loewenthal's* test with sesquichlorid of iron and ferricyanid of potassium will reveal the presence of such compounds of sulphur in chlorhydric acid made with the utmost care, and in other respects pure. By means of chlorine or some similar oxydizing agent, these compounds of sulphur may undoubtedly be oxydized, or at least the larger part of these admixtures may be converted into sulphuric acid; whether their last traces can be oxydized in this way is a point by no means beyond a doubt. But if the chlorhydric acid has been treated with chlorine to accomplish this oxydation, it becomes necessary to remove from the acid the excess of the oxydizing agent, for sulphuretted hydrogen would not be developed from zinc, contaminated with sulphur, by an acid which contained free chlorine, or any substance of like properties. Thus common chlorhydric acid very often contains free chlorine, and no zinc will yield with such acid anything more than a very uncertain reaction for sulphur on lead-paper. To obtain chlorhydric acid which was above suspicion, and unquestionably free from every trace of sulphur, and from every oxydizing agent which might interfere with our reaction for sulphur in zinc, we found so difficult a task, that we finally rejected this acid altogether, and resorted to the following process. A solution of chlorid of calcium, free from every trace of sulphur, was first prepared by dissolving carbonate of lime in chlorhydric acid, adding ammonia in excess to the boiling solution, filtering off the precipitated oxyds of iron and alumina, adding to the filtrate chlorid of barium, and evaporating to dryness. The residue was dissolved in distilled water, and in this solution a slight excess of chlorid of barium was present, as was proved by the precipitate produced by a solution of sulphate of lime. Oxalic acid free from sulphur was then prepared by the following process: a quantity of commercial oxalic acid was treated with enough cold water to dissolve about half of the acid taken, and the cold solution thus obtained was partially evaporated and crystallized; the mass of crystals was washed with a saturated solution of a portion of the crystals, and was finally dissolved in distilled water. In these two reagents, the chlorid of calcium and the oxalic acid, so prepared, no sulphur could be detected, either by barium salts, Loewenthal's test, or by the blowpipe reaction on silver.

"We applied to every zinc in our possession the following test for sulphur. 10 or 15 grammes of zinc were introduced into a small flask, and a portion of the solution of chlorid of calcium and of oxalic acid added thereto; hydrogen gas was freely developed, and was tested for any sulphuretted hydrogen which it might contain, by placing a slip of paper moistened with alkaline acetate of lead in the narrow neck of the flask. In every case the paper was immediately and strongly blackened, showing conclusively that every one of the following zincs contains sulphur in a quantity extremely minute, but distinctly appreciable if a sufficiently delicate test be applied:—

1. Vieille Montagne zinc (in two distinct samples).
2. Silesian zinc.
3. The United States Mint zinc.
4. Pennsylvanian zinc.
5. Rousseau Frères zinc.
6. Berlin sheet zinc.
7. Silesian zinc (subjected to Meillet's† process for purification from arsenic).
8. New Jersey zinc.
9. " " (reduced by us from the New Jersey white zinc oxyd).
10. English zinc (in four distinct samples).

"These results are not in accordance with the statements of some previous observers. Thus Karsten, in the memoir previously cited, infers that sulphur is not contained in Silesian zinc, from the fact that he obtained no precipitate in passing the gas generated by this zinc through a solution of acetate of lead. But it must be remembered, first, that we have no evidence that Karsten's acids were free from oxydizing agents, and secondly, that the reaction for sulphur on lead-paper is a more delicate test than any process of causing the gas generated to bubble through a liquid, even though the best form of apparatus be employed to secure as far as possible thorough contact of the gas with the fluid. Moreover, Karsten subsequently men-

* Jour. pr. Chem., lx, 267.

† Dingler's Polyt. Jour., 1842, lxxxiii, 205, from Jour. de Pharmacie, 1841, 625.

tions that a delicate black precipitate is produced when the hydrogen from zinc is passed through nitrate of silver; this precipitate was probably sulphid of silver, and not metallic silver, as Karsten conjectured.

"Again, Jacquelain, in the memoir already referred to, concludes that sulphur was not contained in the specimen of French zinc which he examined, because a complete solution of the zinc in aqua regia gives no precipitate with chlorid of barium. But obviously the precipitation of sulphate of baryta in aqua regia is by no means a sufficiently delicate test for an amount of sulphur at best exceedingly minute. In the same paper, Jacquelain, criticising the observation reported by Fordos and Gélis of the generation of sulphuretted hydrogen from zinc and dilute sulphuric acid, implies that there is no sulphur in zinc by stating that the development of sulphuretted hydrogen from zinc may be avoided by using properly prepared acid. The acid which Jacquelain used had been saturated with chlorine gas, in a process of which the principal object was the purification of the sulphuric acid from sulphurous acid. That this acid occasioned no development of sulphuretted hydrogen from the zinc is not to be wondered at, but it is not to be argued from this fact, that there is no sulphur in zinc. With regard to sulphur in the zinc from New Jersey, Alger* has remarked that the New Jersey zinc ore is known to contain no sulphur; but, on the other hand, Jackson† observed the sulphuret of zinc in the mine of red oxyd of zinc in Franklin, Sussex County, New Jersey, and a simple experiment demonstrated to us the existence of sulphur in that ore. 10 or 15 grammes of the red oxyd of zinc, not entirely free from the gangue of carbonate of lime in which the ore occurs, were reduced to a fine powder, and treated with moderately dilute pure sulphuric acid. A vigorous evolution of sulphuretted hydrogen was the immediate result."

As a general result it appears therefore that in all commercial zincs metallic lead is the principal impurity: while it is gratifying to observe that the purest of all the zincs which have been analyzed by Messrs. Eliot and Storer is that manufactured at the Pennsylvania and Lehigh Zinc Works, at Bethlehem, Pennsylvania. This spelter leaves no appreciable residue when dissolved in dilute acids, and therefore contains no lead; indeed a trace of cadmium is the only impurity whose presence in the zinc the authors can confidently assert. The ore from which this spelter is made is the hydrated silicate of zinc (electric calamine), and it is not surprising that this mineral should yield zinc of singular purity, if the ore be carefully selected.

We have here purposely omitted any allusion to the valuable discussion upon the occurrence of arsenic in zinc into which the authors have been drawn, since we propose to cite their remarks upon this subject in full in a subsequent number.

2. *A Practical Treatise on Coal, Petroleum, and other distilled Oils;* by ABRAHAM GESNER, M.D., F.G.S. New York. Baillière Brothers, 1860, 8vo, pp. 134.—This book is just what it claims to be in its title, A *Practical Treatise* on the comparatively new art of producing oils for illumination and machinery from coal and its congeners. As a contribution to the recorded technology of an obscure subject it is a decided step in advance. It describes in as simple and direct terms as the inherent complexity of the subject permits, the method of preparing and purifying coal oils and the natural oils (rock oils) allied to them. The scientific chemist as well as the technical manufacturer will find these descriptions plain matter-of-fact statements, of a man thoroughly versed in the practical details and administration of his art, and much of it of a positive and valuable addition to what was previously accessible in books.

* Am J. Sci., xlviii, 253. † Proc. Am. Association, 1850, iv, 336.

The author recognizes the intimate relation of the manufacture of coal oils with the production in such increasing abundance of petroleum, destined to become a powerful competitor of the artificial product, for economic use. He states the number of oil wells in Western Pennsylvania and Ohio as not less than five hundred and fifty, opened or in process of boring, and yielding by estimate not less than 25,000 to 30,000 gallons daily. It is instructive in this connection to recall the fact that the natural product (petroleum) which has been well known from the earliest records of human history, should have remained comparatively useless and almost neglected until the modern art of coal oil distillation, has shown its industrial value. It is quite possible that the future historian of the industrial arts may look back on the coal oil distillation as only an episode in the history of the development of the use of petroleum.

We would not be understood however as giving to Dr. G.'s book an unqualified approval. It abounds in loose, careless statements likely to confuse and mislead his readers; such is his allusion to "Electricity" on p. 17, which he says "plays an important part in the changes which occur during distillation." It is time this force ceased to be the *pons asinorum* whenever in matters of science ignorance lacks the courage to avow its weakness. When (as on p. 59) the author says, "A number of compounds of carbon and hydrogen have been confounded with paraffine—such as methylene, ethylene, butylene," &c., he darkens council by words without knowledge. Since no one is likely to mistake these three *gaseous* products, C_2H_2, C_4H_4 and C_8H_8, the second of which, ethylene, is '*olefiant gas*' and the third is '*oil gas*,' for the beautiful white crystalline paraffine, whose formula may be as our author states, on the authority of Lewis, $C_{20}H_{21}$, or it may be $C_{48}H_{50}$. What he meant to say doubtless was that many substances termed paraffine consist of a mixture of several polymeric hydrocarbons, which form the higher terms of a series to which olefiant gas belongs—which is probably the fact.

Chemists will be curious to know the evidence on which Dr. G. rests the "Homologous series obtained from the bitumen of Trinidad," (page 86) embracing by enumeration nineteen consecutive compounds on the assumed type $C_{n+1}H_n$. Such vague assertions will neither, as he supposes, "interest the professional chemist," or extend the bounds of science. Like too many technical works printed in this country, this book abounds in typographical errors—such as the persistent use of an*a*line for aniline.

Considering the author's well-known position as plaintiff in the case of Gesner vs. Cairnes—we esteem his allusion to the "Albert Coal" to be in bad taste, since it gives only a partizan view of a case where the testimony was very various and evenly balanced, as the printed minutes of the case from the notes of the Judge clearly show.* There are many other things in this book open to criticism which we hope will be corrected in a second edition.

3. *General Problems from the Orthographic Projections of Descriptive Geometry; with their Applications to Oblique—including Isometrical—Projections, Graphical Constructions in Spherical Trigonometry, Topographical Projection, and Graphical Transformations;* by S. EDWARD

* Report of a case tried at Albert Circuit, 1852, before his Honor Judge Wilmot and a special Jury. Abraham Gesner vs. William Cairnes, copied from the Judge's Notes. St. John, N. B., 1853. 8vo, pp. 167.

WARREN, C.E., Professor of Descriptive Geometry and Geometrical Drawing in the Rensselaer Polytechnic Institute, Troy, N. Y., 412 pp., 8vo. New York: JOHN WILEY, 1860.—This is a more extended work than any other American treatise on Descriptive Geometry which has hitherto appeared. It is rigorously systematic and truly philosophical in its general plan, but is open to the objection of being encumbered with a complex system of divisions, and subdivisions in a descending scale, that will not be apprehended readily by the student. Notwithstanding this objection, the work is on the whole admirably adapted to secure the important educational benefits to be derived from such a study —the realization of a true mental culture, as well as the acquisition of exact knowledge. From this point of view the most striking feature is the plan of prefixing to the detailed solution of each problem, an outline sketch of the process, given without reference to a diagram, which the author terms a "Solution in Space." Another commendable feature is the thoroughness, and fullness of detail with which the more important elementary problems are worked up.

The problems relating to each of the four general classes of surfaces are arranged under four distinct heads, or "Classes of Operations;" viz: Projections, Intersections, Tangencies, and Developments. In his mode of treatment of some of these topics the author has displayed considerable originality. The doctrine of tangency especially is presented in a new light. A new definition is given of a tangent line not liable to certain plausible objections that may be urged against the definition generally adopted, and which may be more readily and more distinctly apprehended by the student, and conducts more readily to the rules for drawing tangents to special curves. But if the author desires that the definition he has given shall maintain its ground, the task devolves upon him of showing that it is completely reconcilable with the principles of geometrical analysis, and would accommodate itself to analytical as well as purely geometrical investigations.

We hail with pleasure the appearance of so comprehensive and thorough a treatise upon a branch of mathematics which holds so prominent a place in our schools of practical science, and commend it to the attention of all who are desirous of obtaining a complete knowledge of the mathematical theory of geometrical drawing.

4. *Cooke's Chemical Physics.*—A critical and complimentary notice of Prof. Cooke's elaborate and excellent work, in the London Athenæum for Nov. 17, concludes with these words:

"As an introduction to chemical physics, this is by far the most comprehensive work in our language. We only fear that it may be considered too extended for use in the class-room. We have, however, no doubt that it will find its way into the library of students who are ambitious of laying a secure foundation for their chemical knowledge."

5. SILLIMAN: Principles of Physics—2d edition. Revised and rewritten. Small 8vo, pp. 700. Philadelphia, Peck & Bliss. 1861.—This new edition varies from the first chiefly in the addition of mathematical demonstrations, and problems for exercise, and in the recomposition of nearly the whole of the first two parts—while the whole is enriched by numerous additions, designed to make it an exact and useful manual for the teacher as well as for the student.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Earthquake.*—About 6 A. M., on the 17th of October, 1860, Canada and the northern United States were visited by an earthquake vibration of a more general and impressive character than any which has occurred for many years. The shock appears by the observations of Dr. Smallwood, and others, to have proceeded from the east to the west. Its point of greatest intensity was low down on the St. Lawrence. Near Rivière Ouelle and Rivière du Loup, proceeding thence with diminishing intensity as far west as Hamilton. It was generally felt throughout northern and eastern New England, and as far west as Auburn, in the State of New York. At Newark, New Jersey, it was very slight and this appears to be its extreme southerly reach. Dr. Dawson* has collected the following observations from about twenty places in Canada arranged in order of their longitudes from east to west. It will be observed that the time is earlier in eastern localities, but on comparing Bic and Belleville, nearly nine degrees apart, the difference of time will be seen to be but little less than that due to the difference of longitude. The Hamilton observation would give an earlier time, but as the shock was slight and the testimony of only one observer was recorded, there may be an error. The shock thus appears to have been nearly simultaneous throughout Canada.

Bic, 6 A. M. Three shocks at intervals of some seconds, noise continued for ten minutes.

Green Island, 6, A. M.

Rivière du Loup, 6 A. M. A series of shocks lasting nearly five minutes. A schooner off this place experienced a shock resembling that of striking on a sandbank, and the waters of the Gulf were unusually agitated.

River Ouelle, 6.15 A. M. Very violent, damaging walls and throwing down chimneys, especially in low grounds.

Eboulements, near Murray Bay, 5.30 A. M. Violent. Five other feeble shocks in rapid succession, another at noon and another at 5 P. M. This is the only place where these latter shocks are mentioned, but the hour of the first is probably an error, as Bay St. Paul, quite near Eboulements, agrees in this respect more nearly with other places.

Bay St. Paul, 5.50 A. M. Violent shock; chimneys fell.

St. Thomas (Montmagny) 6 A. M. Two shocks.

St. Joseph de la Beauce, 6.10 A. M.

Quebec, 5.50 A. M. Several shocks, severe, especially in lower parts of the city and in the environs; but less so than at River Ouelle, &c.

Leeds, Megantic, 6.10 to 6.15 A. M.

Richmond, 5.45, A. M.

Three Rivers, about 6 A. M. Shocks felt for two minutes.

Granby, about 6 A. M.

St. Hyacinthe, 5.45 A. M. Three shocks continuing more than a minute, buildings reported damaged.

Maskinonge, 6 A. M. Shocks felt for more than a minute, supposed to be from north to south.

Montreal, 5.50. Two or three perceptible shocks, felt less on the mountain than on lower ground.

St. Martin, Isle Jesus, 5.55. At Dr. Smallwood's observatory, two distinct and smart shocks. The wave passed from east to west. Barometer 29·964 inches, temperature 40° 3, wind N. E., cloudy.

Cornwall, 6 A. M.

Prescott, 5.30 A. M.

Belleville, 5.30 A. M. One shock.

Hamilton, 4.45, A. M.

* Canadian Naturalist, Oct., 1860, 363.

"In all or nearly all of the above places the earthquake was preceded by a rumbling noise which gradually decreased after the vibrations had passed. The difference of duration ascribed to the shocks appears to arise mainly from the circumstance that some observers include the continuance of vibration in buildings, &c., as well as that of the subterranean sound; and in this way it is probable that by some persons two or more shocks have been regarded as one.

"The observation of Dr. Smallwood that the wave proceeded from east to west, may be regarded as correct. At the same time the nearly simultaneous occurrence of the shock throughout Canada, perhaps indicates that the wave did not move horizontally but reached the surface from a great depth and at a high angle as Perrey of Dijon seems to suppose the earthquakes of Eastern America have usually done. It must however be observed that at the rate of propagation given by Mallet for earthquake waves through hard rock, which is not less than 10,000 feet per second, it is quite possible that even a horizontal wave may appear to be felt at the same instant at great distances.

"All the observers agree that the sound preceded the shock and continued after it, and that the first shock was the most violent; and it is also very generally noted that it was most severely felt on low ground and least so on rocky eminences. This last character which belongs to earthquakes generally, seems to arise from the greater resistance opposed to the vibrations by loose materials as compared with hard rocks.

"It appears from the published lists that the late earthquake is the last of at least twenty-nine that have visited Canada since its discovery by Europeans."

3. *Two New Meteorites;* by J. Lawrence Smith, (in a letter to the Editors, dated, Louisville, Ky., Nov. 19th, 1860).—There have just come into my possession, two new meteoric irons; one weighing one hundred and twelve pounds from Oldham County, near LaGrange, Ky.; the other weighing thirty-seven pounds, from Robertson county, near Coopertown, Tenn. A description of them with analyses will be given in an early number of this Journal.

OBITUARY.

J. P. Espy.—The death of Mr. Espy was announced by us in vol. xxix, p. 304; the following notice of his life was communicated by Prof. A. D. Bache, at a recent meeting of the Board of Regents of the Smithsonian Institution, and forms part of the Report for 1859, p. 108.

"James P. Espy, one of the most original and successful meteorologists of the present time, died in Cincinnati, Ohio, on the 24th of January, 1860, in the seventy-fifth year of his age, after an illness of a week, at the residence of his nephew, John Westcott.

The early career of Mr. Espy as an instructor was marked by the qualities which led to his later distinction in science. He was one of the best classical and mathematical instructors in Philadelphia, which at that day numbered Dr. Wylie, Mr. Sanderson, and Mr. Crawford among its teachers.

Impressed by the researches and writings of Dalton and of Daniell on meteorology, Mr. Espy began to observe the phenomena, and then to experiment on the facts which form the groundwork of the science. As he observed, experimented, and studied, his enthusiasm grew, and his desire to devote himself exclusively to the increase and diffusion of the science finally became so strong that he determined to give up his school, and to rely for the means of prosecuting his researches upon his slender savings and the success of his lectures, probably the most original which have ever been

delivered on this subject. His first course was delivered before the Franklin Institute of Pennsylvania, of which he had long been an active member, and where he met kindred spirits, ready to discuss the principles or the applications of science, and prepared to extend their views over the whole horizon of physical and mechanical research. As chairman of the committee on meteorology, Mr. Espy had a large share in the organization of the complete system of meteorological observations carried on by the Institute under the auspices and within the limits of the State of Pennsylvania.

Mr. Espy's theory of storms was developed in successive memoirs in the Journal of the Franklin Institute, containing discussions of the changes of temperature, pressure, and moisture of the air, and in the direction and force of the wind and other phenomena attending remarkable storms in the United States and on the ocean adjacent to the Atlantic and Gulf Coast. Assuming great simplicity as it was developed, and founded on the established laws of physics and upon ingenious and well-directed original experiments, this theory drew general attention to itself, especially in the United States. A memoir submitted anonymously to the American Philosophical Society of Philadelphia gained for Mr. Espy the award of the Magellanic premium in the year 1836, after a discussion remarkable for ingenuity and closeness in its progress, and for the almost unanimity of its result.

Mr. Espy was eminently social in his mental habits, full of bonhommie and of enthusiasm, easily kindling into a glow by social mental action. In the meetings and free discussions in a club formed for promoting research, and especially for scrutinizing the labors of its members—and of which Sears C. Walker, Professor Henry, Henry D. Rogers, and myself were members—Mr. Espy found the mental stimulus that he needed, and the criticism which he courted, the best aids and checks on his observations, speculations, and experiments. But there was one person who had more influence upon him than all others besides, stimulating him to progress, and urging him forward in each step with a zeal which never flagged—this was his wife. Having no children to occupy her care, and being of high mental endowment and of enthusiastic temperament, she found a never-failing source of interest and gratification in watching the development of Mr. Espy's scientific ideas, the progress of his experiments, and the results of his reading and studies; the collection and collation of observations of natural phenomena in the poetical region of the storm, the tornado, and of the aurora. Mrs. Espy's mind was essentially literary and she could not aid her husband in his scientific inquiries or experiments: her health was delicate, and she could not assist him in his out-door observations; but she supplied what was of more importance than these aids—a genial and loving interest ever manifested in his pursuits and successes, and in his very failures. *Alere flammam* was the office of her delicate and poetical temperament. Younger than Mr. Espy, she nevertheless died several years before him, (in 1850.) leaving him to struggle alone in the decline of life without the sustaining power of her devoted and enthusiastic nature.

Having in a great degree matured his theory of storms; having made numerous inductions from observations, and having written a great deal in regard to it, Mr. Espy took the bold resolution, though past middle age, to throw himself into a new career, laying aside all ordinary employments, and devoting himself to the diffusion of the knowledge which he had collected and increased, by lecturing in the towns, villages, and cities of the United States. This proved a successful undertaking, and by its originality attracted more attention to his views than could have been obtained probably, in any other way. He soon showed remarkable power in explaining his ideas. His simplicity and clearness enabled his hearers to follow him without too great effort, and the earnestness with which he spoke out his convictions carried them away in favor of his theory. The same power which enabled him to succeed in his lecturing career procured subsequently for Mr. Espy the support and encouragement of some of the leading men in Congress, and especially in the Senate, and also in the executive departments. Their attention was arrested by the originality of his views and his warmth in presenting them, and he imparted so much of his conviction of their truth as to induce many of our statesmen and official persons to exert themselves to procure for him, under the patronage of the government, continued opportunities for study, research, and the comparison of observations. To the consistent support of his scientific friends, and particularly of the Secretary of this Institution, Mr. Espy owed also much in obtaining the opportunities of keeping in a scientific career. His reports to the Surgeon General of the army, to Congress, and to the Secretary of the Navy, are among his latest efforts in this direction.

The earnest and deep convictions of the truth of his theory in all its parts, and his glowing enthusiasm in regard to it; perhaps, also, the age which he had reached, prevented Mr. Espy from passing beyond a certain point in its development. The same constitution of mind rendered his inductions from observation often unsafe. His views were positive and his conclusions absolute, and so was the expression of them. He was not prone to examine and re-examine premises and conclusions, but considered what had once been passed upon by his judgment as finally settled. Hence his views did not make that impression upon cooler temperaments among men of science to which they were entitled—obtaining more credit among scholars and men of general reading in our country than among scientific men and making but little progress abroad.

Feeling that his bodily vigor was failing, and that his life must soon close, the Secretary of the Smithsonian Institution induced him to re-examine the various parts of his meteorological theories of storms, tornadoes and water spouts, and to insert in his last report, while it was going through the press, an account of his most mature views. I trust that the Secretary will, in one of his reports, give us a thorough and critical examination of the works and services of this remarkable contributor to a branch of science, the knowledge of which the Smithsonian Institution has already done so much to advance and to diffuse."

On motion of Professor Bache, the following resolutions were adopted:

Resolved, That the Regents of the Smithsonian Institution have learned with deep regret the decease of James P. Espy, one of the most useful and zealous of the meteorologists co-operating with the Institution, and whose labors in both the increase and diffusion of knowledge of meteorology have merited the highest honors of science at home and have added to the reputation of our country abroad.

Resolved, That the Regents offer to the relatives of Mr. Espy their sincere condolence in the loss which they have sustained.

On motion of Mr. Pearce, it was resolved that the remarks of Professor Bache be entered in the proceedings.

David Dale Owen, well-known as a geologist and chemist, died at his residence, New Harmony, Indiana, November 13th, 1860, aged 53. Dr. Owen has been long a contributor to this Journal and was widely known and highly esteemed as an assiduous explorer and author in the wide fields of American Geology. He was born June 24th, 1807, at Braxfield House, Lanarkshire, Scotland, where his father, Robert Owen, the eminent Philanthropist, was a large Mill owner. His mother was a daughter of David Dale, once Provost of Glasgow. Dr. Owen from 1823 to 1826, was educated at the well-known establishment of Emanuel Fellenberg, at Hofwyl, Switzerland, with three of his brothers; two of whom, (Hon. Robert Dale Owen, late American Minister Plenipotentiary at Naples, and Dr. Richard Owen,) yet survive. He subsequently spent a year in Glasgow, attending the chemical instructions of Dr. Andrew Ure. In 1828, Dr. Owen accompanied his father to the United States, where some time before, the latter had purchased a part of the town of New Harmony, Ia., as a site for testing his educational and philanthropic plans; arriving at New Orleans after an eight weeks' voyage, in January, 1829. Returning to Europe, in 1831–32,—after commencing his scientific labors in America—he visited Paris for the purpose of perfecting his hand in drawing from models, having a strong natural taste for the pencil, the evidence of which is visible in his numerous original drawings and sketches in his various geological Reports. In London, he resided for the next eighteen months, following the chemical lectures of Dr. Turner and visiting the

Museums and Geological Society. Returning to the United States, he was, in 1833, and subsequently, associated as a volunteer explorer with the late Dr. Troost, then engaged on the Geological Reconnoissance of Tennessee. He received his Medical diploma from the Ohio Medical College, in 1835, after two years' assiduous devotion to medical studies in Cincinnati. In 1837, he married Miss Caroline Neef, daughter of Joseph F. N. Neef, the former associate of Pestalozzi, in Switzerland, and later with Mr. William Maclure, in New Harmony.

Dr. Owen's responsible labors, as an explorer, commenced in 1837, when he took charge of the Geological Reconnoissance of Indiana, performing that labor chiefly on horseback in a comparatively new country. His report on the geology of Indiana, quite a small volume, was last year reprinted, by order of the Legislature of that State.

His appointment by the General Government, in 1839, to examine the mineral lands of Iowa, which it proposed to reserve from sale, resulted in a remarkable *tour de force*, by which he was able in an incredibly short space of time, with the aid of one hundred and ten persons, mostly selected among his fellow-townsmen, to examine each quarter section, (forty acres,) of a territory, 11,000 square miles in extent, and report upon it by the appointed time.* In 1848–50 he again, under the appointment of the General Government, surveyed Iowa; the Commission including also Wisconsin and Minnesota. The results of this Survey appeared in a quarto volume, in 1852, under the sanction of Congress.† This elaborate Report was illustrated by plates of fossils, some of which were 'medal-ruled' on steel, a process never before applied to the delineation of organic remains.

His Report on the Chippewa Land District of Wisconsin, was published under instructions from the United States Treasury Department, in 1849–50.‡ Soon after the completion of his second Iowa Report, he undertook the direction of the Kentucky Geological Survey, the manuscript for the fourth Report of which was sent to press only a few weeks before his death. The three elaborate volumes, already published, on the Kentucky Survey, have been previously noticed by us.§

In 1857, he undertook also the direction of the Geological Survey of Arkansas; the work in Kentucky, being so far completed, as to authorize his assuming new duties. The first volume, (8vo,) of the Arkansas Report, appeared in 1858, and the materials for a second volume, were in the printers' hands, at the time of his death; indeed he continued dictating daily, portions of this Report to within three days of his decease. He had, in 1859, accepted the offer made him by the Board of Agriculture, for the State of Indiana to direct the new Geological Survey of that State, with the understanding that the work should be performed by his brother, Dr. R. Owen, until the completion of the Arkansas Survey permitted his personal attention to that of Indiana. This work, we understand, remains in Dr. R. Owen's hands. Besides these great and responsible labors, Dr. Owen made numerous Geological examinations for individuals and Corporations. It is a great satisfaction to know that Science

* This Journal, [2.] xi, 294. † See this Journal, [2,] xv, 296, xvi, 91.
‡ This Journal, [2,] ix, 1850.
§ This Journal, xxii, 272, xxv, 283, 447, xxix, 287.

will have the benefit of all Dr. Owen's public labors. The second report on the Geological Survey of Arkansas is in the hands of the printer, as also the fourth volume of the Kentucky report.

He has also left a monument of his industry and success in a fine museum and laboratory, at New Harmony, completed during the last year.

The disease of which Dr. Owen died, if not induced, was greatly aggravated by the long and severe exposures and privations to which his almost constant field labors exposed him.

He sleeps in the vault, (which was also that of his own family), of WILLIAM MACLURE, the father of American Geology, already consecrated to science as the last resting place of the eminent naturalist, THOMAS SAY.

Few men have labored more harmoniously with their associates, than Dr. Owen; whose catalogue of collaborators includes, Norwood, Shumard, Meek, Swallow, Lesquereux, Peter, Litton, Elderhorst and Joseph Lesley, Jr. His Reports bear testimony to the eminent sense of justice which led him to assign to each of his associates the share both of honor and responsibility which was his due. Nor should we fail to state that his eldest son, for the last year or two, has been his professional associate and assistant. In view of his great executive and scientific ability, rich experience, and comparative age, science had much to hope for in the continued life of Dr. Owen, and his loss is great in proportion to these reasonable hopes. It will be seen from an advertisement in this Number, that the administrator of Dr. Owen's estate, offers a part of his Scientific property for public sale.

MR. S. A. CASSEDAY died the latter part of September, of "congestive chill." His papers in connection with Mr. Lyon on Crinoidea, published in this Journal, were valuable contributions to American palæontology, to which he had devoted a large share of attention. He was a native and resident of Louisville, Ky.

Bibliography; by J. NICKLÈS.

PARIS, chez MALLET-BACHELIER.

Recherches sur l'équivalent mécanique de la chaleur, par G. A. HIRN. 1 vol. in 8° d. 340 pages, avec planches.—Cet ouvrage a été couronné, par la Société de Physique de Berlin, qui avait mise au concours la question si important, de l'équivalent mécanique de la chaleur.

PARIS, chez HACHETTE, rue Pierre-Sarrazin.

Cours de Droit Naturel, par JOUFFROY. 2 vol. in 12° d. 430 pages; ouvrage essentiellement philosophique et d'une très grande portée.

En Amèrique et in Europe, par MARMIER. 1 vol. 12° d. 480 pages.—Cet ouvrage qui sera sourtout lu avec intérèt par les habitans des anciennes colonies françaises, telles que le Canada, la Louisiane, etc., est la réimpression d'une série d'articles qui out paru dans la Revue des deux Mondes. L'auteur est un voyageur fantaisiste, dont les productions littéraires sont fort en vogue en France.

La Norvège, par LOUIS ENAULT. 1 vol. in 12° d. 450 pages.—C'est un ouvrage du méme genre que le précédent et non moins estimé.

L'année scientifique et industrielle, par L. FIGUIER. 1 vol. in 12° d. 300 pages, 4me anneé.—Ouvrage essentiellement populaire et exposant d'une manière succincte, les principales découvertes accomplies dans l'année dans le domaine des sciences d'observation.

L'année musicale, par SCUDO.—A l'ouvrage de M. FIGUEIR vaut s'annexer l'année musicale, et—

L'année littéraire et dramatique, de M. VAPPEREAU.

PROCEEDINGS BOSTON SOC. NAT. HIST., continued from vol. xxx, 1860, MARCH—p. 241, (also 251.) On consecutive faunæ and their corresponding number of geological formations, as furnishing arguments against the theory of Darwin; *Prof. Agassiz.*—p. 242, Discussion on same by *Prof. Rogers;* and p. 244, rejoinder; *Agassiz.*—p. 245, On the colors of the Nacre of fresh water bivalves; *J. Lewis.*—p. 246, Views of the stratigraphical relations of deposits formed in an ocean under each of the three conditions of a *stationary*, a *subsiding*, and a *rising* position of the sea bottom; *W. B. Rogers.*—p. 249, Occurrence of so-called native Iron in Africa, (vol. v, p. 250, and vol. vi, p. 279, B. S. Proceed.) denied; *A. A. Hayes.*—p. 252, Description of new Ophiuridæ, belonging to the Smithsonian Institution and to the Museum of Comparative Zoology; *Theodore Lyman.*—p. 262, Genus *Pygorhynchus* (genus known before only fossil,) found living at Acapulco; *Agassiz.*—APRIL.—p. 271, On the distinctness of faunæ in time and space; *Prof. Agassiz.*—p. 273, Remarks, (supplementary,) on the movements of the ocean-floor; *W. B. Rogers.*—p. 274-5, discussed by *Agassiz, Rogers* and *Gould.*—p. 276, Exhibition of the albino children and a sketch of albinism, by *Dr. Kneland.*—Habits and distribution of the Gorilla, and other anthropoid apes from personal observation on the West Coast of Africa; *M. Du Chaillu.*—p. 277, Table comprising the age, weight and height of 100 men from a Military Company in Boston; *Dr. B. J. Jeffries.*—MAY.—On two migratory parasites; *Prof. J. Wyman.*—p. 283, On some sub-Peat Deposits of Diatomaceæ; *A. M. Edwards*, New York.—p. 287, On the American White Ant, (*Termes frontalis, Hald.*); *S. H. Scudder.*—p. 290, On the "cocoanut pearl;" a rare calcareous concretion found in the interior of the Cocoa-nut; *Dr. J. Bacon.*—p. 293, Dissection of the poison apparatus of the Rattle Snake; *Dr. J. Wyman.*—p. 294, On the Albert Coal; *Prof. W. B. Rogers.*—p. 296, Descriptions of five new species of mammals discovered in West equatorial Africa; *P. B. Du Chaillu.*—p. 305, Analysis of juice of the leaf-stalks of common Rhubarb, [*R. rhaponticum*]; *C. T. Jackson.*—p. 305, List of the Birds of Cuba, compiled from two lists presented by D. J. Gundlach of Havana; *Dr. T. M. Brewer.*—p. 308, Notes upon the mode and plan of nidification of some of the Birds of Chili; *M. F. Germain*, of Santiago, presented by *Dr. Brewer.*—p. 306, On the foot-marks of the Connecticut River Sandstones; *Roswell Field.*—p. 317, Report on the Registering Thermometer of Dr. James Lewis; *Prof. W. B. Rogers.*—p. 319, Observations on the Geology and Palæontology of Burlington, Iowa; *C. A. White.*—Remarks on the last by Prof. *W. B. Rogers.*—p. 322, Observations by Mr. L. W. Bailey, in relation to an interesting locality of Diatomaceæ, at Oaklands, North Providence; *Prof. W. B. Rogers.*—p. 323, Descriptions of new shells collected by the United States North Pacific Exploring Expedition; *Dr. A. A. Gould.*—SEPTEMBER.—p. 345, "Report on supplying the city of Charlestown, Mass., with pure water," and on the phenomena connected with the tides at Mystic Pond; *Dr. A. A. Hayes.*—Synonymy of the species of Cyrenella, a genus of Mollusca belonging to the family of the Lucinidæ; *Temple Prime.*—p. 348, On a very fusible white mineral from Lake Superior, containing boracic acid; *Dr. A. A. Hayes.*—p. 349, Account of a recent visit to the coast of Labrador; *Dr. Henry Bryant.*—Account of a visit to some old mines in the vicinity of Franconia, N. H.; *Dr. C. T. Jackson.*—p. 350, On the fungous growth commonly called California beer seed; *Dr. White.*—Fossil skull of the Capybara; *The President.*—OCTOBER.—p. 353, On the conglomerate of Vermont; *Prof. Edward Hitchcock.*—p. 355, Letter in reference to a Canada lynx (*Lynx Canadensis*), killed in Carlisle, Mass., Sept. 9, 1860; *H. D. Thoreau.*—p. 356, Account of a recent visit to Lake Winnipeg and the Saskatchawan River; *S. H. Scudder.*—On the age of some of the sandstones of North America, generally considered as the Old Red Sandstone; *Prof. Agassiz.*—p. 357, On the black slate of Braintree, Mass., containing *Paradoxides*, and on similar strata in Newfoundland, near Lake Champlain, and in the vicinity of Quebec; *J. Marcou* (for a full report see p. 369).—NOVEMBER.—p. 358, Descriptions of ten mammals from equatorial Africa, collected by himself, and believed to be undescribed (continued); *Mr. DuChaillu.*—p. 367, Notice of a visit to Green Island, off the mouth of Chester Bay, Nova Scotia, by the Rev. I. Ambrose, M.A., Halifax; *Dr. Bryant.*—p. 382, Descriptions of new shells collected by the North Pacific Exploring Expedition (continued); *Dr. A. A. Gould.*

For list of books received, see March Number.

THE

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[SECOND SERIES.]

ART. XIII.—*On the Appalachian Mountain System;* by ARNOLD GUYOT, Professor in the College of New Jersey, Princeton. With a map.

THE remark has been made with justice that the Appalachian or Alleghany system of mountains, although situated in the midst of a civilized, nation is still one of the chains concerning which we have the least amount of positive knowledge. This is especially true respecting the height of the culminating points of different portions of the system. A great number of measurements, have indeed been made within the last thirty years, for the construction of railroads and canals and for other practical purposes, but this net-work of surveys, it is easy to understand, has included only the basis of the system, and the lowest points at which it may be crossed. Everything not connected with practical objects has received but little attention. True, a certain number of barometrical measurements were made a long time ago, chiefly in the north; they have not, however, proved to be exact when compared with the measurements which I have lately made with greater care and under more favorable circumstances. But we must not attribute the rarity and the imperfection of mountain measurements wholly to a want of interest in science or to the absolute preponderance of the utilitarian spirit which characterizes America. It is due, in a considerable degree, to the difficulty, which has existed until within a very few years, of procuring good instruments, and to the obstacles, often very great, which the explorer meets in these wild

regions. A chain of thirteen hundred miles in length is a vast field, especially when it includes mountains covered with interminable forests, where a footpath rarely guides the traveller's step, and which it is impossible to cross except with a hatchet in the hand and with a loss of time and strength often quite disproportionate to the results which are obtained. Add to this, that in many parts of the system, the journey is to be made in an unknown region, without a reliable map, far from a human dwelling, rarely penetrated by the most hardy hunters. The explorer must be ready to march without any trusty guide, and to sleep in the open air, exposed to the inclement temperature of the elevated regions, and obliged to depend for nourishment on the food which he can carry with him. In these circumstances the danger of perishing from exhaustion is by no means imaginary, as I know by experience.

In a great portion of the Appalachian chain, especially toward the south, the lofty forests which crown nearly all the summits, and the thick underbrush, literally impenetrable, of Rhododendrons and other evergreens, in which the faint track of the bear is often the only assistance of the traveller, are not less serious obstacles. The difficulty of obtaining general views enabling one to take his bearings in the labyrinth of mountains which cover the country, is thus considerably increased; and the favorable points of observation which are necessary to determine the position of the peaks which are measured or to be measured, and for identifying them in every case are by no means numerous. Besides all this, if the relative height of different culminating points has been determined correctly, there still remains, in order to fix their absolute height, the difficulty of determining the altitude of the points of departure or of the lower stations which are often hundreds of miles from the sea coast.

These various difficulties, or at least some of them, have diminished within the last ten years. Excellent barometers are now made in America and are within the reach of any willing observer. The railroad surveys cross all the principal sections and furnish a great number of points whose altitude is sufficiently determined to serve as a point of departure for measuring the summits throughout nearly the whole extent of the system. Moreover hypsometrical tables adapted to all the barometrical scales, partly compiled and partly computed by the writer, have been published by the Smithsonian Institution, and relieve the observer of the most tedious and time-consuming portion of his task, by reducing the computation of barometrical heights to the simplest arithmetical operation. These tables can be found in the volume of "Meteorological and Physical Tables" which, by the liberality of the Institution, is now accessible to every scientific man.

One of my first labors, on arriving in America, in 1848, was to collect all the measurements of the Appalachian system which had then been published. Except the elevations determined for railroads and canals, nearly all the more remarkable heights which had been measured were in New England or New York, that is to say, in the White, Green and Adirondack mountains. Add to this the secondary heights measured, in considerable number, in Maine, New Hampshire and Massachusetts, a few points in Pennsylvania and Virginia, and some rather vague determinations in North Carolina, by Dr. Mitchell, and we have nearly all the hypsometrical wealth then at the service of the geographer. Massachusetts, the only state in the Union which has had a regular trigonometric survey, furnished besides some geodetic points determined with great accuracy. The same may be said of the admirable work of the Coast Survey still progressing under the skillful direction of Prof. A. D. Bache; but the points geodetically measured are seldom distant from the coast. All the other altitudes which were published had been obtained by barometric measurement.

The comparison of these last soon led me to see in the heights published by different authors such differences as indicated either a confusion of names, or errors in measurement too considerable to be attributed to the formulas employed in calculating, and which could only be attributed to imperfect instruments, or to circumstances too unfavorable for the work which was undertaken. As for detecting the error, when there was a disagreement, it was hopeless; for, since most of the authors gave merely their results, without the observations from which they were deduced, and without describing the instruments employed, or the circumstances of the measurement, a discriminating criticism was impossible. Moreover, the measurements which I had occasion to verify were nearly all found to be affected by errors more or less considerable. I was therefore led to regard them all only as approximations which by no means superseded the necessity of new determinations.

Since 1849, I have devoted my summer excursions to a study of the physical configuration of the Appalachian system, and to the barometric measurement of those points which were most important in the establishment of the laws of its relief. I began with the most remarkable culminating groups, namely, the White Mountains, where I made four excursions in as many different summers, the Green Mountains and the Adirondack. I afterwards visited in three excursions the central and southern portions of Virginia, and the vast group of elevated chains which covers the western part of North Carolina, between the boundaries of Tennessee, Georgia and South Carolina, and which form, as my observations fully show, the culminating region of the whole Appalachian system.

I intend to continue these explorations, so far as circumstances permit, in order to collect sufficient facts for forming a just idea of the normal proportions of the system in all its parts. Meanwhile I present the list of results already obtained, hoping that this preliminary publication will afford some interest to scientific men. At the same time I desire to have it considered as a *resumé* merely of special memoirs in which I shall give the original measurements, and shall indicate the details of the work and the method employed for deducing these results. It is my wish to do my part toward establishing an usage which should be invariable among men of science, to give the elements on which are based the results, which should be in the common treasure of our knowledge. This would furnish to sound criticism the means of determining their proper value. In this particular case, however, such details may be more fitly placed in the transactions of scientific societies.

I present the following altitudes with some degree of confidence. An acquaintance of more than twenty years with the barometer, and the thousands of measurements which I have made in the Alps and elsewhere, have long ago initiated me into the theoretical and practical difficulties of the barometric method and of the instrument itself. In all measurements I have had a double object. I desired not only to obtain an accurate result, but also to perfect the barometric method. I hope I have been able to eliminate some errors and uncertainties which too commonly affect its working, and tend to throw upon the method a degree of distrust which should rather rest upon the observers themselves. At another time I may offer some further remarks upon this subject. At present I will only add that the value of the coëfficients in the formula of Laplace must be slightly modified, in accordance with the more recent determinations of the physical data which it employs, and that the corrections which depend upon the temperature and the hour of the day in which the observations are made, deserve a much closer degree of attention than has hitherto been accorded to them.

In the volume of Physical and Meteorological Tables, published by the Smithsonian Institution, I have mentioned two instances in which my barometric measurements were followed the next year by leveling with a spirit level. This occurred in the two culminating points of the Appalachian system, Mount Washington in the White Mountains of New Hampshire, and the summit of the Black Mountains in North Carolina. The received height of Mount Washington had previously been 6226 feet. My measurements in 1851 gave 6291 feet. The measurements by spirit level, by U. A. Godwin, Civil Engineer, in 1852, gave 6285 feet, and a similar leveling under the direction of the Coast Survey in 1853, gave a height of 6293 feet.

For the Black Dome of North Carolina, the culminating point of the Black Mountains, (lately called also Mitchell's High Peak, but not the former Mount Mitchell,) my measurements in 1856 gave 6702 feet, or, by adopting the modification of the coëfficient just alluded to, 6707 feet. A measurement by spirit level in the following year, 1857, by Major J. C. Turner, Civil Engineer, who had my figures in his hand, and who set out from my point of departure, gave an altitude of 6711 feet.

To these coincidences I may add examples still more recent. Waynesville, the chief town in Haywood County, North Carolina, 27 miles from Asheville, being one of my principal stations for the measurement of all the culminating region of the Appalachian System, I determined its altitude with care by a series of hourly correspondent observations extending through several days, one at Asheville, the other at Warm Springs, thirty-seven miles below the French Broad river, near the boundary of Tennessee, the altitudes of these two points being given by the Survey of the Charleston and Cincinnati railroad which follows the valley of the French Broad, beyond the mouth of the Swannanoa. The Asheville series, in 1859, gave for the altitude of the base of the Waynesville Court House 2756 feet, assuming 2250 feet for the altitude of the Asheville Court House, according to a leveling which I was told had been executed between that point and the railroad track near the bridge of the Swannanoa. This figure of 2756 feet is that which I published early in July, 1860, in an Asheville newspaper. If I adopt the mean of the barometric measurements which I made for determining the elevation of Asheville, I find it to be 2246 feet, and Waynesville becomes 2752 feet. The series of 1860, which began at one of the benches of the railroad at Warm Springs, and which includes an intermediate station at Finescreek, gives also for Waynesville 2752 feet. But Col. Robert Love, of Waynesville, informs me that the altitude of this same point, as given to him by the Engineers of the Western North Carolina railroad, (who had just finished the location of that road,) was also 2752 feet.

I owe to the courtesy of Mr. Presstman, chief assistant of Maj. Jas. C. Turner, Chief Engineer of the road, a communication of the altitude of two other points also included in the list of published elevations, already mentioned, to wit, the summit of the route which crosses the Balsam chain at the upper end of Scott's creek, and the confluence of this creek with the Tuckaseege, twenty miles from Waynesville. In both cases, the railroad levelings agreed within a yard with the barometric measurements, these last being the highest.

These measurements, entirely independent, and proceeding from the same given points, present an argument which is well fitted to inspire confidence in barometric results obtained with fitting precautions.

I scarcely need to add that I cannot pretend to guarantee a similar degree of accuracy in the greater number of heights measured which rest upon a single observation. All those who are acquainted with the hypsometric method fully know that, in the determinations obtained, either by the theodolite, or by the barometer, accuracy is only secured by repetitions so numerous as to permit the elimination of accidental errors incident to the variable state of the atmosphere. I may say, however, that I have taken especial precautions to avoid the two principal causes of error in barometric measurements; namely, the unequal variation, both in time and quantity, of the atmospheric pressure in the corresponding barometers, and again, the errors in the determination of the true mean temperature of the air, at the hour of observation, whether by day or by night. To prevent the first I have taken a special care to locate the corresponding barometers at stations generally distant much less than twenty, and rarely exceeding thirty miles from the points measured. As to the second, when it was not possible to eliminate the errors due to the temperature of the air, by combining observations taken both by day and by night to produce a compensation, I have resorted to the aid of tables formed from a great number of experiments to be mentioned hereafter.

That which induces me to believe that the results resting on a single observation also deserve a good degree of confidence is that having had occasion to repeat the measurement of a great number of points previously determined by careful observations, both in the Black mountains and in the county of Haywood, in different years and under different conditions of the atmosphere, the new results did not differ from those previously obtained by more than one to three yards. When the height of a mountain is known within these limits of approximation the claims of physical geography may be regarded as satisfied.

The barometers which I have employed in these different measurements are a series of Fortin barometers, modified by Delcros, and manufactured by Ernst, at Paris. These instruments, with the exception of one which is my own property, have been imported by myself under the authority of the Smithsonian Institution, for the purpose of determining by direct comparison, the relation between the standard barometer of the observatory at Paris, and the standard barometer intended for the Institution. They have been kindly left at my disposal by the Secretary, for the prosecution of these hypsometrical researches.

These instruments have been compared with the utmost care, not only before and after each excursion, but also during the progress of each, whenever there has been an opportunity. The corresponding observations have always been made with one or the other of the barometers thus compared, and their relative corrections, resulting from the equations thus established, have

always been applied in the calculations. A long familiarity with Gay Lussac's syphon barometer, with Bunten's improvement, as well as with Fortin's cistern barometer, modified by Ernst, has convinced me that the latter is to be preferred, notwithstanding its weight and its greater length, if the utmost accuracy compatible with the method is to be sought. The variations of capillary attraction, and the soiling of the tube of the short branch of the syphon by the oxyd of mercury in the Bunten barometer are serious inconveniences. The impossibility of repairing such barometers in case they are injured in travelling, is a still more serious difficulty. I carry with each of my Fortin barometers, two extra tubes and a bottle of purified mercury which enable me in case of accident to reconstruct my barometer in two hours time, even in the depths of the wildest forest. This advantage is of the utmost value in America where every explorer must trust to himself and his own resources, unless he is willing to be constantly deprived of his instruments. It is difficult for me to think coolly of so many scientific expeditions, sent at great expense into unexplored countries, in which observations, even if made with an inferior instrument, would have had great value, but in which all barometric measurements became impossible by the fracture of the instrument at the outset of the journey. Such an excuse, under the ordinary circumstances, of an official expedition, is quite inadmissible.

Such were the considerations which led me to introduce in this country and especially recommend the modified Fortin barometer, when in 1849, '50, '51, I was charged with establishing, in the states of New York and Massachusetts, fifty meteorological stations under the scientific direction of the Smithsonian Institution. Acting in its behalf I superintended the construction of a series of meteorological instruments of which the manufacture was entrusted to a skillful optician, Mr. James Green, of New York, and which are now extensively employed throughout the United States, under the name of the Smithsonian Meteorological Instruments. I especially endeavored to render these instruments strong, simple and adjustable. By the latter phrase, I mean that their construction allows them to be regulated by a standard instrument so as to eliminate the error of zero in the thermometer, and in the barometer the total error due to capillarity and to the peculiarities in the construction of each instrument, so that they will all give immediately absolute values conformed to the same standard, and consequently comparable with one another. In the thermometer it is enough to suspend the tube to the scale by means of a screw, which permits the tube to be moved along the scale until the zero of the mercury coincides with that of the scale. In the barometer I obtain this result by means of a moveable scale which slides upon the brass casing

of the barometric tube and which is so placed as to make its indications accord with those of the normal barometer. A line traced on the fixed scale marks the natural height of the column of mercury and makes apparent the value of the applied correction.

Each instrument made by Green, bearing a fixed number, and having been carefully compared with the standard (such, at least is the direction given) its indications may be immediately compared with those of any other of the same maker. This adjustment is evidently important for stationary observations, for it dispenses with the task of reducing by an applied correction each series of observations to a standard scale. For travelling observers and for the measurements of heights the scale of adjustments becomes of no account since it is enough to compare carefully with one another, the barometers which are employed, and to determine their equations, which otherwise are liable to vary and ought to be constantly observed anew. It is consequently better to dispense with the moveable scale, which may be disarranged by the accidents incident to a journey.

After many different experiments, and at the suggestion of Mr. Green, the cistern was modified, and instead of the two parts of the cistern screwing upon each other, a system which occasioned frequent leakage of the mercury, a means of closure by planes of contact was substituted, which not only make leakage impossible, but permit the opening and dismounting of all the parts of the cistern at any time, with the utmost ease. This construction is not only stronger, but it greatly facilitates the cleansing of the mercury, which it is well to attend to frequently. Finally it dispenses with cement and as the cistern is of injected box wood, the evil effects of extreme temperatures and of extreme moisture and dryness are avoided. Barometers of this construction are now in use throughout America, having been substituted for those of Bunten in the army meteorological stations, and having been employed in the numerous expeditions of the Pacific railroad surveys. I accordingly consider the introduction of these instruments at an epoch, when for various reasons, scientific researches were so rapidly increasing in America, as a very fortunate circumstance in enhancing the value of these same observations; for I may add that previous to this epoch, with the exception of a very few instruments imported from Europe, I scarcely found in the hands of the observers in this country a single barometer which had a scientific value.

The preceding details will not be void of interest to those who have occasion to make use of the observations recently made in America in official and other explorations. As for my own observations I would mention that they have been constantly accompanied by corresponding observations made by my young

friends who have attended me in the various excursions, and who have studied under my direction the use of the barometer. I ought particularly to mention Mr. Ernest Sandoz, who has been with me in nearly all my excursions, and Mr. Emile Grand Pierre, who was my companion during three summers. I have also received the kind assistance of Dr. Bache, the Superintendant of the Coast Survey, who caused a series of corresponding observations for the measurement of Mt. Washington in 1851, to be made by two of his assistants, Messrs. Edward Goodfellow and B. F. West.

I would also mention Dr. Algernon Coolidge, who accompanied me to the Green Mountains, and to whom I owe, in addition to corresponding observations, the measurement of the Camel Hump. My young friends, Alexander Agassiz, Edward Rutledge, and Herbert Torrey, have given me active coöperation in the White Mountains. To my friend and fellow traveller in the Black Mountains, Rev. W. H. Green, of Princeton, I owe a number of corresponding barometric observations, and likewise a number to Prof. W. C. Kerr, of Davidson College, and to Mr. W. A. Benners, of Waynesville.

The corresponding observations, made by my companions in travel, were taken hour by hour, and sometimes even once every quarter of an hour, so as to allow the construction of a complete barometric curve which represents with great exactness the state of the barometer for any hour of the day, and renders the error of interpolation almost null.

For the purpose of distinguishing accurately the relative position of the regions explored, it may be well to describe the general structure of the system of mountains to which they belong.

The upheavals of ancient rocks which constitute this well connected physical structure, for which, as a whole, it is proper to retain the common name of the Appalachian system, extend in an undulating line thirteen hundred miles in a mean direction of N.E. to S.W., from the promontory of Gaspé upon the Gulf of St. Lawrence to Alabama, where the terminal chains sink down and are lost in the recent and almost horizontal strata of the cretaceous and tertiary formations which cover the greater portion of the surface of this state. This long range of elevations is composed of a considerable number of chains, sensibly parallel to each other, occupying more particularly the eastern part which faces the ocean, and of an extended plateau which prevails towards the west and northwest and descends gradually towards the inland valleys of the St. Lawrence, the lakes Erie and Ontario and the Ohio river.

The base on which this large belt of mountains rests, and which may be considered as bounded by the Atlantic Ocean on one side and by the Ohio and St. Lawrence rivers on the other,

is formed, in the east, by a plain slightly inclined towards the Atlantic. The width of that plain, in New England, does not vary much from fifty miles. Near the mouth of the Hudson, however, in New Jersey, it nearly disappears, but gradually increases towards the south to a width of over two hundred miles. Its elevation above the sea, at the foot of the mountains, is in New England, from 300 to 500 feet. From the neighborhood of the bay of New York, where it is nearly on a level with the ocean, it rises gradually towards the south to an altitude of over 1000 feet. On the west the table-lands which border upon the Ohio River, and which may be considered as the general base of the system, preserve a mass-elevation of a thousand feet or more, in the thickness of which the river-bed is scooped out to the depth of from 400 to 600 feet, thus reducing the altitude of the Ohio River full one-half from that of the surrounding lands.

The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which in general, runs parallel to the inflections of its chains with remarkable regularity. This system, composed of a series of corrugations tolerably uniform, does not, like the Alps, or the other great systems of fracture, have a central or main axis, to which the secondary chains are subordinated. But it is properly compared to the system of the Jura, for it is composed like that of a series of long folds, or chains, which run parallel to each other, often with great regularity. In the same part of the system the general height of the chains is sensibly equal and their summits show neither many nor deep notches. In the middle region, especially in Pennsylvania and New Jersey, they present the appearance of long and continuous walls, the blue summits of which trace along the horizon a uniform line seldom varied by any peaks or crags. In the extreme northern and southern portions, however, this character is considerably modified. There the system loses very much of its uniformity and its physical structure becomes far more complicated; the form of simple parallel ridges almost entirely disappears.

There is one feature of the Appalachian system which distinguishes it from the ranges of the Jura; it is the well marked division into two longitudinal zones of elevation, one turned towards the shores of the Atlantic, in which the form of parallel chains just spoken of predominates, and the other turned towards the interior, which is composed of elevated and continuous plateaus, descending from the summit of their eastern escarpment, in the centre of the system, in gentle stages towards the basins of the lakes and the valley of the Ohio. Occasionally minor chains, very little elevated from their base, wrinkle the surface of the table lands. Their parallelism with those of the eastern mountainous

zone shows that they are but the last undulations due to the action of the same forces which have upheaved and folded that region, and which have raised at the same time, the mass of these more uniform plateaus. Thus when from any point we traverse the Appalachian system from the Atlantic, we encounter first a plain more and more undulated and gradually ascending to the foot of the mountains; then a mountainous zone with its ranges parallel and its valleys longitudinal; at length a third zone of uniform plateaus slightly inclined towards the northwest, and cut with deep transverse valleys.

Another feature not less conspicuous characterizes the region of corrugations properly so-called. This is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the Great Appalachian valley. At the north it is occupied by lake Champlain and the Hudson river; in Pennsylvania it bears the name of Kittatinny or Cumberland valley. In Virginia it is the Great valley; more to the south it is called the valley of East Tennessee. At the northeast and at the centre its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley towards the southeast is the more continuous and extends without any great interruption from Vermont to Alabama. In Vermont it bears the name of Green Mountains, which it retains to the borders of New York; in the latter State it becomes the Highlands; in Pennsylvania the South Mountains; in Virginia the Blue Ridge; in North Carolina and Tennessee the Iron, Smoky, and Unaka Mountains. On the northwest of the great valley between the latter and the borders of the plateau parallel there extends a middle zone of chains separated by narrow valleys, the more continuous of which is the range which bounds the central valley. This zone has a variable breadth in different parts of the system, and the number of chains which compose it is by no means uniform throughout.

Although these features are common to the Appalachian system throughout its entire length, nevertheless it may be divided from north to south into three *divisions* which present very remarkable differences of structure. Passing the eye over the physical chart which accompanies this article we at once distinguish in the longitudinal extent of the Appalachian system two principal curvatures, the one at the north from Gaspé to New York, the concavity of which is turned towards the southeast; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the southeast; the third from New

River to the southwest extremity of the system, the direction of which is nearly straight or forming a gentle curve concave towards the northwest. These three divisions, diminishing in extent, from the north to the south, are well marked, at the north, by the deep valleys of the Mohawk and the Hudson, which break through the Appalachian system to its base and across its entire breadth; at the south, by the New River whose deep valley with vertical walls also separates regions whose orographic characters present remarkable differences.

The *northern division* is much the most isolated; it is geologically the most ancient, since its upheavals appear coeval with the Silurian and Devonian epochs, and are thus much anterior to the rest of the system, which only emerged after the deposit of the carboniferous rocks which it has elevated. Four hundred feet more of water would separate all the vast territory of the northern division from the American continent. One hundred and forty feet would convert into an island all New England and the British possessions as far as Gaspé; for the bottom of the valley occupied by Lake Champlain and the Hudson does not in any part exceed this level.

I distinguish in this northern portion three physical regions; 1st, the triangular plateau of the Adirondack, with its mountain chains more or less parallel, between Lake Champlain and the St. Lawrence, Lake Ontario and the Mohawk: 2nd, New England, with the two swells of land separated by the deep valley of the Connecticut, and forming the base of the Green and White mountains: 3rd, the northern region, with the prolongation, towards the northeast, of the same features of relief, from the source of the Connecticut through Maine into Canada and New Brunswick to the promontory of Gaspé and the bay of Chaleurs.

The *middle or central division* extends in length about 450 miles. The eastern region, or region of folded chains, at first very narrow about New York, presents towards the centre, in Pennsylvania, its greatest breadth which again diminishes towards the south. It is composed of a considerable number of chains much curved towards the west, and remarkable for their regularity, their parallelism, their abrupt acclivities, the almost complete uniformity of their summits, and their moderate elevation, both relative and absolute, which varies from 800 and 1500 to 2500 feet. The chains, however, increase in elevation towards the south, while they become more numerous and more indented. In the Peaks of Otter, in Virginia, they attain to 4000 feet.

The western region, or the region of plateaus, is quite narrow in the southern part, but acquires towards the north the greatest breadth which it attains in any part of the Appalachian system. Its high terraces occupy all the State of New York south of the Mohawk, and a considerable part of Pennsylvania and culminate

in the plateaus in the neighborhood of Lake Erie, where the mean altitude of the plateau reaches 2000 feet, the valleys preserving a height of 1500 feet while the hills reach 2600 feet.

This tableland forms a remarkable water-shed from which the waters descend by the Susquehanna into the valley of the Chesapeake and the Atlantic ocean, by the Genesee and St. Lawrence to the same ocean, and by the Alleghany and Ohio to the Gulf of Mexico. The Susquehanna thus starts from Lake Erie at the extreme western border of the plateau, and runs across all the Appalachian system and its mountain ranges to its eastern base. More to the southward the eastern escarpment of the plateau divides, as far as the sources of the Potomac, the waters of the Atlantic coast from those of the Gulf of Mexico. It is the same escarpment which bears the local name of Alleghany Mountain, a name which continues to be applied, south of the waters of the Potomac, to the dividing ridge along the sources of the various branches of James River, and even to the irregular hills which form a water-shed between the waters of the upper Roanoke and New River, across the Great Valley, near Christiansburg. Through all this middle region the name of Blue Ridge is applied to the main eastern chain which separates the Great valley from the Atlantic slope, and which is cut by all the rivers which flow out of it.

The *southern division*, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only 100 to 300 feet in Pennsylvania, and 500 in Virginia near James river, it is 1000 to 1200 feet in the region of the sources of the Catawba. In the interior of the mountain region the deepest valleys retain an altitude of 2000 to 2700 feet.

From the dividing line in the neighborhood of Christiansburg and the great bend of New River the orographic and hydrographic relations undergo a considerable modification. The direction of the principal parts of the system is also somewhat changed. The main chain which borders the Great valley on the east, and which more to the north, under the name of the Blue Ridge, separates it from the Atlantic plain, gradually deviates towards the southwest. A new chain detached on the east, and curving a little more to the south, takes now the name of Blue Ridge. It is this lofty chain, the altitude of which, in its more elevated groups, attains gradually to 5000 and 5900 feet, which divides in its turn the waters running to the Atlantic from those of the Mississippi. The line of separation, of the eastern and western waters, which, to this point, follows either the central chain of the Alleghanies, or the western border of the table-

land region, passes now suddenly to the eastern chain, upon the very border of the Atlantic plain. The reason is that the terrace which forms the base of the chains, and the slope of which usually determines the general direction of the water courses, attains here its greatest elevation, and descends gradually towards the northwest. The base of the interior chain which runs alongside the Great valley is thus depressed to a lower level, and though the chain itself has an absolute elevation greater than that of the Blue Ridge, the rivers which descend from the summits of this last, flow to the northwest towards the great central valley which they only reach, in southern Virginia and North Carolina, by first passing across the high chain of the Unaka and Smoky mountains through gaps of 3000 or 4000 feet in depth.

This southern division thus presents from southeast to northwest three regions very distinct.

The first is the high mountainous region comprised between the Blue Ridge and the great chain of the Iron, Smoky, and Unaka mountains which separate North Carolina from Tennessee. It commences at the bifurcation of the two chains in Virginia, where it forms, at first, a valley of only ten to fifteen miles in breadth, in the southern part of which flows New River; it then enlarges and extends across North Carolina and into Georgia, in length more than 180 miles, varying in breadth from twenty to fifty miles. The eastern chain, or Blue Ridge, the principal water-shed, is composed of many fragments scarcely connected into a continuous and regular chain. Its direction frequently changes and forms many large curves. Its height is equally irregular. Some, groups elevated from 5000 feet and more, are separated by long intervals of depression in which are found gaps whose height is 2200 to 3700 feet, often but little above the height of the interior valleys themselves with which they are connected. The interior, or western chain, is much more continuous, more elevated, more regular in its direction and height, and increases very uniformly from 5000 to nearly 6700 feet.

The area comprised between these two main chains, from the sources of the New River and the Watauga, in the vicinity of the Grandfather Mountain, to the southern extremity of the system, is divided by transverse chains into many basins, at the bottom of each one of which runs one of those mountain tributaries of the Tennessee, which by the abundance of their waters merit the name of the true sources of that noble river.

Between the basin of the Watauga and that of the Nolechucky rises the lofty chain of the Roan and Big Yellow mountains. The northwest branch of the Black mountain and its continuation as far as the Bald mountain separate the basin of the Nolechucky from that of the French Broad river. Between the lat-

ter and the Big Pigeon river stretches the long chain of the Pisgah and the New Found mountains. Further to the south the elevated chain of the Great Balsam mountains separates the basins of the Big Pigeon and the Tuckasegee; next comes the chain of the Cowee mountains between the latter river and the Little Tennessee. Finally the double chain of the Nantihala and Valley River mountains separates the two great basins of the Little Tennessee and the Hiwassee. The bottom of these basins preserves in the middle, an altitude of from 2000 to 2700 feet. The height of these transverse chains is greater than that of the Blue Ridge, for they are from 5000 to 6000 feet and upwards; and the gaps which cross them are as high, and often higher than those of the Blue Ridge. In these interior basins are also found groups, more or less isolated, like that of the Black mountains, which, with the Smoky mountains, present the most elevated points of the system.

Here then through an extent of more than 150 miles, the mean height of the valley from which the mountains rise is more than 2000 feet; the mountains which reach 6000 feet are counted by scores, and the loftiest peaks rise to 6700 feet; while at the north, in the group of the White mountains, the base is scarcely 1000 feet, the gaps 2000 feet, and Mount Washington, the only one which rises above 6000 feet, is still 400 feet below the height of the Black Dome of the Black Mountains. Here then in all respects is the culminating region of the vast Appalachian system.

It is worthy of notice that in t .e Appalachian, as in many other systems of mountains, the culminating points are situated, neither near the middle, nor in the neighborhood of what may be called its central axis, which is here the Great valley, but near the northern and southern extremities, and on the eastern side, almost outside of the system. These culminating regions seem almost exceptions to the normal structure of the system. The high mountainous region of North Carolina which has just been described is, from the bifurcation of the Blue Ridge near the great bend of the New River, an additional fold which attaches itself on the east along the principal chain which bounds the Great Valley, just as the swell, which runs along the east of the Connecticut River, upon which the group of the White mountains is situated, is an additional fold attaching itself to the east of the normal chain of the Green mountains.

The second region of this southern division is the continuation of the Great Central Valley which is divided by a general swell of the land about the sources of the Holston, into two distinct basins, the one in Virginia, narrower and more elevated, which in the basin of the New River, rises gradually towards the south from an elevation of 1600 feet to 2600 feet; the other in Tennessee, where the valley widens to nearly sixty miles between

the Smoky mountains and the Cumberland mountains, but where it has a mean elevation of not more than about 1000 feet, that is, only one-half of the height of the neighboring valleys in the mountainous region of North Carolina.

The third region is that of the plateaus which, in Tennessee, are reduced to a table land about thirty or forty miles wide, called the Cumberland mountains on account of the abrupt edges which it presents upon the east and the west, and which give to it the appearance of a mountain chain. Further north, in Virginia, the plateaus expand and fill a vast area to the west of the Clinch and the Cumberland mountains and extend over a part of Kentucky, the central portion of which, near Lexington, preserves an altitude of more than 1000 feet.

The rapid sketch here given shows that in a hypsometrical, as well as from a geological, point of view, and even to a certain extent from its physical structure, the Appalachian system seemed to be divided into two sections of nearly equal extent; a *northern section*, which is geologically more ancient, comprehending the northern division from the mouth of the Hudson to Gaspé; and a *southern section*, which is more modern, comprising the central and southern divisions, which are bound together by more than one characteristic common to both. The separation is distinguished by a remarkable general depression of all the altitudes of the eastern zone, or parallel mountain chains, a depression which attains its lowest point in New Jersey in the parallel of New York City.

Passing from this region, where the Blue Ridge and the Kittatinny mountains are but little more than 800 or 1000 feet high, and the Great valley 50 to 150 feet, the altitude in the northern section increases rapidly, but regularly, towards the northeast, where, almost in the same parallel, lat. 44° N., we find the culminating points at Mount Washington 6288 feet high in the White Mountains, Mount Mansfield 4430 feet in the Green Mountains, and Mount Tahawus or Mount Marcy 5739 feet, in the Adirondack group. Further north the Adirondack group terminates, and the Green Mountains lose somewhat of their continuity, but show here and there, as far as Gaspé, scattered groups of mountains which still preserve an elevation of 3000 or 4000 feet.

In the southern section the altitude increases from the northeast to the southwest with the same regularity but less rapidly, and it is only towards the extremity of the system in North Carolina that they attain their maximum elevation in the Black Mountains 6700 feet, and the Smoky Mountains 6660 feet. Here, as at the north, beyond the culminating points the general altitude is but little diminished until we arrive almost to the termination of the mountains.

The following figures demonstrate the law which I have announced above:

Upon the ridge which borders the Connecticut river on the east and where the elevation gradually increases from the sea coast until it reaches in Connecticut 1000 feet, in Massachusetts 1100 feet, and in New Hampshire 1600 feet at the sources of the Connecticut river, we meet with a series of mountains more or less isolated, which appear to have no other relation to each other than that they are placed on a common base.

The most remarkable of these, proceeding from the south towards the north are the following:

Mount Wachusett, in Massachusetts, - -	2018	feet	high.*
Grand Monadnock, in New Hampshire, -	3718	"	"
Moosehillock " " " - - -	4790	"	"
Lafayette Mount, } Group of - -	5290	"	"
Mount Washington, } White Mountains, -	6288	"	"

In the double chain of Green Mountains are the following remarkable peaks gradually increasing in height from the south to the north:

North Beacon, in the Highlands of the Hudson,	1471	feet	high.
Bald Peak, in Massachusetts, - - - -	2624*	"	"
Greylock, or Saddle Mount, in Massachusetts,	3505*	"	"
Equinox Mount, in Vermont, - - - - -	3872	"	"
Killington Peak, " - - - -	4221	"	"
Mansfield Mountain, " - - - - -	4430	"	"

North Beacon was probably measured by Capt. Partridge, the others were measured by myself.

In the Adirondack group I have cited only the most elevated point, Mount Tahawus or Mount Marcy, which is the only one of the great peaks which I have as yet measured. I found its height 5379 feet. This height differs from that of Redfield given in the Geology of the State of New York, (5467 feet), and from that of Prof. T. Benedict, (5341 feet). But it is to be remarked that the heights given by the first are all too great by reason of the defective nature of the instrument employed, as I have had occasion to convince myself; and also that Prof. Benedict, although provided with a Bunten barometer, was only able to make use of corresponding observations made at a considerable distance. From Tahawus the height of the peaks diminishes both towards the north and towards the south and the chains dwindle away before they reach Lake Champlain or the Mohawk River.

In the southern part the law of gradual increase is still more regular. It can also be exhibited at the exterior base of the mountains, along the Great valley, and in the principal chains

* Geodetic points in the triangulation of Massachusetts.

which border it. I have already said that the interior border of the Atlantic plain rises gradually from 50 to 1200 feet, from New Jersey to the upper region of the Catawba, near Morganton. The grade of the railroads gives us in the Great valley a series of significant points:

The Great valley at Easton, on the Delaware in Penn.,	165 ft.
" " " near the Schuylkill, Penn.,	250 "
" " " at Harrisburg, on the Susquehanna,	328 "
" " " at Chambersburg, Penn.,	600 "
" " " near Staunton, south fork of Shenandoah, in Central Virginia,	1261 "
" " " at Salem, in the upper valley of the Roanoke,	1014 "
" " " Newbern in the valley of New River,	2065 "
" " " Mt. Airy Ridge, highest point near the sources of the Holston,	2595 "
" " " Abingdon, in Southern Virginia,	2071 "
" " " Bristol, on the N. boundary of Tennessee,	1678 "
" " " Greenville, Tennessee,*	1581 "
" " " Knoxville, "	898 "
" " " Chattanooga, "	675 "

The principal chain along the eastern border of the Great valley under the name of Blue Ridge, Iron, Smoky and Unaka Mountains, presents in the same manner an increasing altitude.

Blue Ridge in New Jersey about 1000 to - -	1500	feet.
Peaks of Otter in Virginia, the highest, - - -	3993	"
White Top, on the boundary of Virginia, North Carolina, and Tennessee, - - - - - - -	5530	"
Bald Mountain, west of the Black Mountains, - -	5550	"
Smoky Dome, Clingman's Mountain, culminating point in the chain of the Smoky Mountains, - -	6660	"
Thunderhead, in Smoky Mountains, - - - -	5520	"
Great Bald, highest peak, in Smoky Mountains, near the cut of Tennessee River, - - - - -	4722	"
Hangover, highest peak of the Unaka Mountains, about	5600	"
Great Frog Mountain in Tennessee, highest peak near the south end of the System. - - - - -	4226	"

The chain which from Christiansburg takes the name of Blue Ridge and forms the barrier which separates the waters along the Atlantic plain does not appear to exceed the altitude of 4500 feet in Virginia. This is only an estimate, for I have made no measurements in this portion of the Blue Ridge. In North Carolina the culminating points are much higher, but more to the south they gradually decrease as far as Georgia.

* I am indebted to Prof. Jas. M. Safford, State Geologist of Tennessee, for a statement of the altitudes on the railroads through this State.

Grandfather Mountain, at the sources of the Yadkin and Watauga rivers, measures - - - - -	5897 feet.
The High Pinnacle, which touches the Black Mountain,	5699 "
Great Hogback, at the sources of the Tuckasegee, - -	4792, "
White-Side, near the sources of the Chatooga, - -	4931 "
Mud Creek Bald, near the head of Little Tennessee, Georgia,	4705 "
Tray Mountain, in Georgia, at the sources of Hiwassee River, - - - - - - - - -	4426 "

Furthermore the transverse chains, which in North Carolina unite the two principal chains, and the interior isolated groups in which the highest summits are found, present altitudes increasing as they proceed, culminating, however, more towards the north.

Roan Mountain, High Knob, which joins the Iron mountain chain on the east, - - - - - -	6306 feet.
Black Dome, or Mitchell's High Peak, the culminating point of the Appalachian System, - - -	6707 "
Richland Balsam, in Big Pigeon Valley, - - - -	6425 "
Amos Plott's Balsam, in Tuckasegee valley, - -	6278 "
Yellow Mountain, Cowee Chain, between the Tuckasegee and Little Tennessee valleys, - - - - -	5108 "
Standing Indian, highest point in the Nantihala chain,	5518 "
Fodders' Bald, in Hiwassee valley, Georgia, - - -	4821 "

The law of general increase of altitude towards the southwest in all parts of the Appalachian system, is thus fully established; but it is to be remarked that the different elements of which it is composed do not arrive to their maximum of altitude in the same locality nor in the same latitude. The bottom of the Great valley reaches its greatest elevation near the sources of the Holston, at about 37° N. lat. The mass elevation, or terre-plein, culminates in the vicinity of Grandfather and Big Yellow mountains. The isolated groups and intermediate chains, culminate in the Black mountains, a little south of 36° N. lat., although, in this region, the principal chains on the two sides do nowhere rise to 6000 feet; while these last, the Blue Ridge and the Smoky Mountains, reach their greatest mean and absolute height at the north of 35° N. lat., between the valleys of the French Broad and Little Tennessee, in the northern part of Haywood and Jackson counties. Although the high peaks of the Smoky mountains are some fifty feet lower than the isolated and almost exceptional group of the Black mountains, by their number, their magnitude, the continuity and general elevation of the chains, and of the base upon which they repose, they are like a massive and high citadel which is really the culminating region of all the Appalachian system.

To complete this brief review I ought to add that this increasing altitude towards the south which is so well marked in the mountain zone of the Alleghanies, is scarcely observed in the

zone of the plateaus. A transverse section from New York to Lake Erie shows that the depression of the system does not extend to the western zone which preserves in appearance a height very nearly uniform, from the plateau of Adirondack in the State of New York as far as to the Cumberland mountains in Tennessee. There is here no well marked region of subsidence as in the eastern zone, but only a tendency to it which is slightly manifested upon a line between the maximum of eastern depression and Pittsburg. It is towards that central line of depression that the Alleghany and Monongahela rivers flow from opposite directions, thus proving the existence of inclined planes which meet about Pittsburg, forming a sort of shallow trough. North of this line the plateaus rise to the sources of the Alleghany and Susquehanna rivers, where, as was said above, they reach an altitude of over two thousand feet; still keeping, further north, on the table-land of Adirondack a mean elevation of 1500 and 1600 feet. Towards the south also the plateaus rise to the sources of the Monongahela. In Virginia and Tennessee they appear to reach 2000 or 2500 feet, at least near the mountains, but the measurements which I possess are too few in number and too uncertain to allow me to speak with certainty on this subject.

This remarkable depression of the Appalachian system in the region noticed, of which the bay of New York is the center, causes a great part of the continental plains, which form the natural base of the mountain folds, to disappear under the waters of the ocean. The waters of the tide thus come to bathe the very base of the mountains, and the region of plains fades away on the frontiers of New Jersey and New York, while towards the south the emerged portion enlarges gradually as it rises according to the law of gradual increase indicated above, so that it reaches a breadth of more than 200 miles in the Carolinas. This depression seems to be due to a local subsidence of the earth crust at an epoch, undetermined, it is true, but which must have been posterior to the principal upheaval of the Appalachian mountains. A fact, the discovery of which is due to the sagacity of Prof. J. D. Dana, seems to give weight to this opinion. He demonstrated by means of numerous soundings marked upon the excellent marine charts published by the U. S. Coast Survey, the existence of an ancient channel, a continuation of that of the Hudson river, which goes out from the bay of New York through the Narrows and advances far out under the waters of the ocean. It is not possible to suppose that such a channel which is constantly liable to be obliterated by sand banks formed by the motion of the sea, could have ever been formed in its present position. In order that the current of the river should excavate this channel it is necessary to suppose that the bottom of the sea has once occupied a higher level,

above, or very near the surface of the ocean. The shallowness of the ocean for a considerable distance from the coast of New Jersey also indicates a prolongation of the continental plains under the sea, and the limit of the deep waters is there found at a distance nearly double that which is observed off the coast of the Carolinas. Moreover the parallelism which exists between the line of coasts and all the great general inflections of the Appalachian system, a parallelism which is well marked from Nova Scotia to Florida, here undergoes a modification which is well explained only by a local depression of this part of the system. The fact that all New Jersey is now undergoing gradual submergence from Cape May to the Bay of New York, which is proved by the numerous facts gathered by Prof. G. H. Cook in the Geological Survey of the State of New Jersey, is here not without signification.

The disposition of the relief indicated above would be readily accounted for by supposing that it is the result of a tilting motion from the north to the south, which, while depressing the northern portion below the mean altitude, elevated the southern region in the same proportion, the centre or axis of the tilt being in the vicinity of Christiansburg, near the Great Bend of the New River. As the movement affected more particularly the eastern, or mountainous belt, and not that of the plateaus of the west, the result of it was a twisting, the effect of which was to raise, in the southern part, the mass of the land on the extreme eastern border and thus to produce an inclined plane towards the northwest; while in the northern part, the general depression of the land along the Atlantic, a depression not participated in by the plateaus of the northwest, left to these latter all their altitude and produced an inclined plane from the extreme western border towards the southeast. It is then this particular disposition of these two general slopes which gives us the key of the hydrographic system of the central and southern divisions of the Appalachian mountains, which at the first glance appears so abnormal. In the central section, as has been remarked above, north of New River, the water-shed is situated along the edge of the plateaus in the Alleghany mountain proper in Virginia and Pennsylvania, from which descend the James River and the Potomac; and still further to the west in the plateaus of New York from which flow the Susquehanna and the Delaware, traversing all the chains of the mountainous region to the Atlantic. In the southern division, south of New River, the water-shed between the Atlantic and the Mississippi basin is situated upon the summit of the Blue River at the extreme eastern edge, and the numerous tributaries of the Tennessee which descend from it also traverse the whole mountainous region, but in an inverse direction, from the southeast to the northwest, and, united in the

Great Valley at the very foot of the plateaus of the northwest, flow down by the sole channel of the Tennessee to the basin of the Mississippi.

As many of the names of mountains given below in the list of the heights measured are new, I may be allowed a few words on the subject of mountain nomenclature.

It is a mistake to suppose that names have been given to even the most prominent points in the mountains of the Appalachian system. Just in the wildest and most elevated regions, such as western North Carolina, for instance, the great majority of them have yet to be named. In a country without a regular chart, and in the midst of forests rarely visited, far from any human habitation, and in places where the primitive inhabitants have disappeared, leaving scarcely a trace of their traditions, it is not surprising that this should be the case.

The uniformity of physical configuration in a great portion of the system does not favor distinguishing different parts by specific names. Frequently people are satisfied with giving a name to a mountain range, or to a district of great extent. The observer who measures the height of definite points must do more. In order to make his labors useful, he ought to designate them individually, and determine their position so that they can always be identified, or afterwards traced upon a chart. It is, therefore, almost a matter of necessity for him to sketch such a map while proceeding, and to name, either ill or well, the points determined by his observations. A good geographic nomenclature, however, is not an easy thing; the chart of the United States proves this.

The names of objects in physical geography now in use in this country are essentially of three kinds. The Indian names which have been bequeathed to us by the aborigines, and are applied more commonly to the water courses and lakes, and especially to their towns or districts; descriptive names, as White Mountains, Black Mountains, Green Mountains, which designate entire chains or groups of mountains; and the names of men, which are applied to all. These last are the more numerous.

Wherever an Indian name is in use it ought to be preserved except where, as sometimes happens, its pronunciation is impossible for us. These names, especially in the languages of the south, are often harmonious and they are all significant, but unhappily without meaning for us. In the south they are rarely applied to mountains, although the Indian name of a river which flows near frequently extends to a neighboring chain of mountains. Indian names, designating special mountain peaks, are not common, perhaps because not preserved by the white settlers, who did not live with, but succeeded the Indian population. The more modern descriptive names have the defect of

great similarity, for in an extent of thirteen hundred miles the topographical characters are singularly analogous. The multiplication of the same name in all parts of the system becomes here, as in political geography, a serious evil. Green, Blue, and Black mountains are found alike at the south and at the north; White mountain, White face, White side, &c., are also numerous. Chestnut, Oak, Pine mountain and Laurel mountains are found everywhere. In the South, Balsam mountains occur at every step from southern Virginia to Georgia. This name designates a mountain whose summit is covered with *Pinus Balsamifera*, or with its analogous species, *Pinus Frazeri*, which only grow on heights which exceed 5000 or 6000 feet. The Bald Mountains whose summits are destitute of forests, a thing comparatively rare at the south, are yet very numerous. It only remains for the geographer, in order to avoid intolerable confusion, to add to such names another name, or epithet, as Richland Balsam, Smoky Bald, and other similar designations.

These difficulties explain, and excuse perhaps in part, the frequent use in America of names of men to designate places, rivers, and mountains. This course requires the least effort of the imagination. A river without a name commonly takes that of the first planter who erects there his cabin or farm-house, and if there is a remarkable mountain near, it is soon designated by the same name. This is the origin of a great number of the names, more convenient than elegant, of the mountains and valleys of the Alleghanies. It is but recently, since scientific measurements have been made, that the names of men, distinguished either in the political or scientific world, have been given to prominent mountains in New England, in the state of New York and at the South.

The principles which have seemed to me proper and which have guided me in the adoption of names of mountains are to give preference to the name employed in the immediate neighborhood of the point designated. When more than one name has been given to the same point, as happens when it is seen from valleys on two different sides of the mountain, it seems proper for the observer to adopt that name which appears most natural or more euphonic. When the choice lies between the name of a man and that of a name which is descriptive and characteristic, I should choose the latter. In regard to points without established names, but recently named by scientific observers, and not by residents of the country, the right of priority ought to be respected, provided the identity of the points can be sufficiently established, a matter by no means easy, unless the positions have been determined by instruments, or otherwise, with considerable care. But it is evident that popular usage will decide in the last resort and that the name universally adopted

will, in time, become that which geography ought to accept. When I have myself given names to mountains, I have almost always preferred a descriptive name to any other; but I acknowledge that the invention of names is a thankless and difficult task. I have, therefore, frequently had recourse to the names of neighboring rivers, or to a fortuitous circumstance, or to some little adventure, connected in my memory with this or that point to designate it, without any other object than that of distinguishing it from every other, since here as elsewhere it is better to accept almost any name rather than to leave it all in confusion.

The map which accompanies this paper was first published in Petermann's *Mittheilungen*, No. vii, 1860: it was drawn, in Gotha, with all the data at his command, by my friend and assistant Mr. E. Sandoz under the kind and skillful direction of Dr. A. Petermann, who by his admirable cartographic labors and manifold services rendered to the science of the physical globe, has long since placed himself among the most useful and scientific geographers of the day. The special map of the Black Mountain has been constructed from my own observations; the points measured having been located by means of a portable theodolite and sextant. In the map of the White Mountains the position of the points measured has been taken from the anonymous map which we owe to Prof. Bond, of Cambridge Observatory, and which was constructed from similar observations by himself. In this new edition of the general map an important correction has been made. The mountain region of North Carolina was engraved anew from a sketch founded upon my observations of 1859 and 1860. A map of that interesting region, on a larger scale, and one of the Black Mountains, showing the position of all the points measured, are in preparation and will be published, together with the discussion and results of the barometric observations, in the Smithsonian Contributions, to which I must refer for further details.

The accompanying list of heights which I have measured is classified according to physical regions. The measurements are of two kinds: those which are marked B are the heights regularly measured by the barometer; those marked P L are heights measured at a distance with a pocket level in the following manner. Wishing to measure a mountain in sight, at a moderate distance, and not exceeding in elevation the one on which I stand, I seek, with the instrument in hand, a point on a level with the summit of the mountain to be measured. Taking then at that point a barometric observation, I consider the result, corrected for the curvature of the earth and for refraction, as the height of the mountain. With an accurate level, a signal upon the mountain, and the knowledge of the exact distance a meas-

urement thus taken would stand the same chance of accuracy as the former; with a pocket level, without a telescope, the results must be considered as approximations which may be very nearly correct, but which also may, according to the distance from which the observation was taken, vary by the height of a tree, that is to say from thirty to fifty feet. They are therefore only preliminary measurements which, while the country remains comparatively unknown, have their proper value in physical geography. I have added for reference a few points marked R R, which are elevations obtained from recent surveys for railroads, and L, which are also determined, for other purposes, by spirit-level. The chart was in part engraved before the revision of the heights given below. New measurements of points previously determined having since taken place, their results ought to have their due influence on the final values. It may happen therefore that there may be found a difference of several feet between the figures given in the table and those inscribed in the map; in those cases the figures given in the table are those which I regard as nearest to the true height. Some ancient measurements of heights in New England have been inadvertently inserted in the chart such as Wachussett 3000 instead of 2018, and some others of this sort which have been recently corrected.

The heights are given in English feet, and above mean tidewater. They are all reduced to the ground, or, for the rivers, to the level of the water.

Culminating Region of the Northern Section.

WHITE MOUNTAINS AND VICINITY.

Western Slope.—Valley of the Amonoosuc.

		Height.
R.R.	Connecticut River, junction with Wells River,	407
R.R.	Bath village,	521
R.R.	Lisbon village,	577
R.R. and B.	Littleton, R. R. station,	817
R.R.	Whitefield, summit between Littleton and Lancaster,	1057
	Whitefield village,	957
R.R.	Lancaster village,	860
R.R.	Israel River, Lancaster bridge, St. Lawrence and Atlantic R. R.	849
B.	Bethlehem village,	1450
B.	Carrol house,	1428
B.	Bethlehem bridge on the Amonoosuc,	1221
P.L.	Brabrook's hotel,	1551
B.	Fabyan's Hotel (old house, now burnt),	1583
B.	Crawford Hotel (Crawford house), White Mt. Notch,	1920
B.	Franconia village, iron foundry,	921
B.	Gilmanton Hill, summit between Franconia and Littleton,	1329
B.	Franconia Valley, crossing of road to Bethlehem,	979
B.	Franconia Notch, Profile house,	1974
B.	Franconia Notch, height of land towards Franconia,	2014
B.	Echo Lake,	1926
B.	Cherry Mt., Summit road,	2192
B.	Cabin, foot of Lafayette Mt.,	1780
B.	Flume house, road front of the Hotel,	1431
B.	Thornton, road opposite the Post Office,	1223
R.R.	Plymouth R. R. station,	473

Eastern Slope.—Valley of the Saco.

		Height.
B.	Notch of White Mts., Crawford house,	1920
B.	The Notch,	1904
B.	Willey house, road opposite the hotel,	1335
B.	Old Crawford's or Davis's hotel,	986
B.	Hart's location, Farm junction, Sawyer's River,	880
B.	Upper Bartlett's Post Office,	644
B.	Crossing of the road's junction of the Saco and Ellis River valleys,	576
B.	South Conway Post Office,	450
Δ	Pleasant Mt., east of Freyeburg, Me. (Coast Survey),	2021

Valleys of Ellis and Sawyer's Rivers.

B.	Jackson Village, hotel foot of the Falls,	771
B.	Pinkham Notch, summit near Glen Ellis Falls,	2018
B.	Junction of Carrigain Brook and Sawyers River,	1494

Northern Slope.

R.R.	Gorham, N. Hampshire, R. R. station, St. Lawrence and Atlantic R. R.,	802
L.	Glenhouse hotel,	1632
B.	Bowman's place, Summit road, between Moose and Israel Rivers,	1446
R.R.	Lowest Summit, R. R. Summit " " " " " "	1473
B.	Peabody River, crossing of path near Glenhouse,	1543
R.R.	Great Androscoggin River at Bethel station,	632
R.R.	Paris station, St. Lawrence and Atlantic R. R.,	396
R.R.	Little Androscoggin River at Danville junction,	276

Mt. Washington, the main chain or the chain of the Presidents, ascending from White Mountain Notch.

B.	Mt. Clinton,	4320
B.	Mt. Pleasant,	4764
B.	Mt. Franklin,	4904
B.	Mt. Monroe,	5384
B.	Mt. Washington, culminating point of northern section,	6288
B.	Mt. Clay,	5553
B.	Mt. Jefferson,	5714
B.	Mt. Adams,	5794
B.	Mt. Madison,	5365
B.	Lake of the Clouds, head waters of Amonoosuc River, foot of Monroe,	5009
B.	Gap between Madison and Jefferson,	4912
B.	" " Jefferson and Adams,	4939
B.	" " Adams and Clay,	4979
B.	" " Clay and Washington,	5417
B.	" " Washington and Monroe,	5100
B.	Little Monroe, W.S.W. of Monroe,	5204
B.	Gap between Franklin and Pleasant,	4400
B.	" " Pleasant and Clinton,	4050
B.	Limit of trees on Washington, N. side, and Madison,	4150
B.	Halfway house on new road, below the Steep slope,	3840
B.	Limit of trees on Clinton,	4250

Secondary chains around the main.—West of Amonoosuc River.

B.	Mt. Deception, near Fabyan's,	2449
P.L.	Cherry Mt., approximately,	3670

Chain, East of Peabody R. and Glenhouse.

P.L.	Wildcat Mt.,	4350
P.L.	Mt. Carter, South Peak,	4830
P.L.	Mt. Carter, North Peak,	4702
P.L.	Mt. Morijah,	4653
P.L.	Crawford Mt.,	3134

Chains South of the Amonoosuc River.

P.L.	Echo Mt., highest point,	3170
P.L.	The Villey, or Notch chain, the lowest or 3d N.W. peak,	4070
P.L.	Middle or highest peak, very much as Clinton by level about,	4330
P.L.	Willey Mt. proper, 1st or East peak,	4300
P.L.	Twin Mt., the highest peak,	4920

South side, between Saco Valley and Merrimac River.

		Height.
B.	Carrigain Mt.,	4678
B.	Summit of Eastern Spur,	4419
P.L.	Brick house Mt., in the line N.E. 2 miles from Carrigain,	3850
P.L.	Pemigewassett Peak,	4420
P.L.	Tremont Mt.,	3393
P.L.	Green's Cliff,	2958
P.L.	Table Mt., 3 miles S.S.E. of Hart's ledge,	3305
P.L.	Sandwich Dome, above Campton,	3969
P.L.	Mad River peak, head of Mad River,	4397
P.L.	Whiteface, N.E. peak, the highest,	4030
P.L.	Tripyramid, N.W. of Whiteface, S. of Carrigain,	4086
P.L.	Chicorua, highest peak south,	3540

Group of Franconia Mts.

P.L.	Eagle Cliff, facing the Profile house,	3446
B.	Eagle head, near the pond,	4216
B.	Eagle pond, foot of last peak,	4170
B.	Lafayette or Great Haystack,	5290
B.	" " " South peak,	5101
P.L.	Summit of Blue or Bog-Eddy Mt., the highest part of the chain of Cannon, Kinsman and Blue Mt.,	4370
P.L.	Kinsman Mt. about	4200
B.	Cannon Mt., the prospect, appr.,	3850

West and South of the White Mts.

B.	Moose hillock, highest peak north,	4790
P.L.	Carr's Mt., highest summit,	3480
P.L.	Owl's head,	2950
P.L.	Webster side, south side of the R. R. opposite,	2210
B.	Highest farm foot of Moose hillock S.,	1681
R.R.	Warren Village,	736
R.R.	Summit of Road,	1063
R.R.	East Haverhill,	773
R.R.	Woodville R. R. station opposite Wells' River,	448
R.R.	Connecticut low water, " " "	407
R.R.	Rumney R. R. station,	520
R.R.	Plymouth village, R. R. station,	473
R.R.	Meredith Village,	542
R.R.	Concord, N. Hampshire, R. R. station,	237

Redhill and Winnipeseogee Lake.

R.R. and Canal.	Lake Winnipeseogee, mean level,	501
B.	Senter house at Centre Harbor, Lake Winnipeseogee,	553
B.	Eastern summit of Redhill,	1769
B.	Western summit " "	2025

GREEN MOUNTAINS.

B.	Manchester R. R. station,	713
B.	" Village courthouse,	864
B.	Equinox Mt., highest peak,	3872
R.R.	Rutland R.R. station,	530
B.	Herrick Mt., near Rutland,	2692
B.	Shrewsbury Peak,	3845
B.	Pico Mt., north of Killington,	3954
B.	Killington Peak,	4221
R.R.	Waterbury R. R. station,	425
P.L.	Hogback Mt.,	3648
B.	Stowe Village, foot of Mansfield Mt.,	700
B.	Mansfield Mt., the Nose,	4094
B.	Mansfield Mt., the Chin, highest,	4430
P.L.	Sterling Chain,	3700
B.	Camel Hump,	4088
P.L.	Lincoln Mt.,	4078

PLATEAU AND MOUNTAINS OF ADIRONDACK.

Profile from Lake Champlain to Mt. Tahawus from E. to W. by N.

		Height.
L.	Lake Champlain, mean level,	93
B.	Crown Point tavern,	206
B.	Bradford farm, road summit,	695
B.	Amyhill summit road,	844
B.	Buckhollow, hamlet water of Putnam Creek,	719
B.	Penfield, water of Putnam Creek,	910
B.	Height of land dividing the Hudson and St. Lawrence waters,	1190
B.	Hammond's furnace,	1132
B.	Paradox Creek at Hammond's saw-mill,	911
B.	" " " crossing of road from Paradox Lake to Root's,	873
B.	Summit of road between Paradox crossing and Johnson's pond,	1256
B.	Johnson's pond,	964
B.	Summit of road between Johnson's pond and Root's in Schroon valley,	1262
B.	Root's farm, ground, in Schroon Valley,	842
B.	Sturtevant's mill on Mud creek,	1118
B.	Mudpond creek,	1206
B.	Summit of road between Mud creek, crossing of French's,	2013
B.	French's farm, road before,	1962
B.	Grand Boreas river, bridge,	1736
B.	Summit road, west of Boreas river,	1935
B.	Lake Sanford at Millpond,	1731
B.	Adirondack Village, or McIntyre's iron-works, hotel,	1785
B.	Summit above Beaver Marsh,	2782
B.	Lake Colden,	2786
B.	Hudson River, Great Bend,	3264
B.	Limit of trees on Mt. Marcy and Whiteface,	4851
B.	Mt. Tahawus or Mt. Marcy,	5379
L.	Lake Henderson,	1829
L.	Head of Falls,	2550
L.	Surface of Beaver marsh,	2677
L.	Summit above Beaver marsh,	2762
L.	Surface of opalescent River (Hudson),	2744

These last five altitudes are derived from levels above Lake Sandford taken by Prof. E. N. Horsford.

Culminating Region of the Southern Section.

THE BLACK MOUNTAINS AND VICINITY.

Valley of the Swananoa.

R.R.	Junction of Flat Creek with Swananoa River,	2250
B.	Joseph Stepp's house,	2360
B.	Burnett's house,	2423
B.	Lower Mountain house, Jesse Stepp's house, floor of Piazza,	2770
B.	W. Patton's cabin, end of carriage road,	3244
B.	Resting place, brook behind last,	3955
B.	Upper Mountain house,	5246
B.	Passage, main branch of Swannanoa above Stepp's ascending to	
B.	Toe River Gap,	3902

In the Blue Ridge.

B.	Toe River Gap, between Potatoe Top and High Pinnacle,	5188
B.	High Pinnacle of Blue Ridge,	5701
B.	Rocky Knobs, south peak,	5306
B.	Big Spring on Rocky Knobs,	5080
B.	Greybeard,	5448

Craggy Chain.

B.	Big Craggy,	6090
B.	Bull's Head,	5935
B.	Craggy Pinnacle,	5945

The Black Mountain, main chain.

B.	Potatoe Top,	6393
B.	Mt. Mitchell,	6582
B.	Mt. Gibbs,	6591
B.	Stepp's Gap, the cabin,	6103

		Height.
B.	Mt. Hallback (or Sugarloaf),	6403
B.	Black Dome (or Mitchell's high peak, or Clingmann of State map),	6707
B.	Dome Gap,	6352
B.	Balsam Cone (Guyot of State map),	6671
B.	Hairy Bear,	6610
B.	Bear Gap,	6234
B.	Black Brother (Sandoz of State map),	6619
B.	Cattail Peak,	6611
B.	Rocky Trail Gap,	6382
B.	Rocky Trail Peak,	6488
B.	Cattail Gap,	5720
B.	Deer Mt., North Point,	6233
B.	Long Ridge, South Point,	6208
B.	" " Middle Point,	6259
B.	" " North Point,	6248
B.	Bowlen's Pyramid North End,	6348

The Black Mountain, Northwestern Chain.

B.	Blackstock Knob,	6380
B.	Yeates's Knob,	5975
B.	Cock's Comb,	5426

Caney River Valley.

B.	Green ponds at Th. Wilson's, highest house,	3222
B.	Th. Wilson's new house,	3110
B.	Wheelers' opposite Big Ivy Gap,	2942
B.	Cattail fork Junction with Caney River,	2873
B.	Sandofer Gap or low Gap, Summit of Road,	3176
B.	Burnsville, courtsquare,	2840
B.	Green Mountain near Burnsville, highest point,	4340

Group of the Roan Mountain.

B.	Summit of Road from Burnsville to Toe River,	3139
B.	Toe River ford on the Road from Burnsville to the Roan Mountain,	2131
B.	Baily's farm,	2379
B.	Brigg's house foot of Roan Mt., Valley of Little Rock creek,	2757
P.L.	Yellow Spot above Brigg's,	5158
P.L.	Little yellow Mount, highest,	5195
B.	The cold spring summit of Roan,	6132
P.L.	Grassy Ridge Ball N.E. continuation of Roan Mt.,	6230
B.	Roan high Bluff,	6296
B.	Roan high Knob,	6306

From Burnsville to Grandfather Mountain.

B.	South Toe River Ford,	2532
B.	Toe River; ford near Autrey's,	2547
B.	North-Toe River ford, below Childsville,	2652
B.	Blue Ridge, head of Brushy creek,	3425
B.	Linville river ford below head of Brushy creek,	3297
B.	Linville River at Piercy's,	3607
B.	Headwaters of Linville and Watauga River, foot of Grandfather Mt.	4100
B.	Grandfather Mt. summit,	5897
B.	Watauga River at Schull's millpond,	2917
B.	Taylorsville, Tennessee,	2395
B.	White Top, Virginia, corner of Tenn. and N. Car.	5530

From Burnsville to the Bald Mt.

B.	Sampson's Gap,	4130
B.	Egypt cove at Proffitts,	3320
B.	Wolfs' camp Gap,	4359
B.	Bald Mt. summit of highest peak,	5550

These four points computed by me from observations made by Prof. W. C. Kerr of Davidson College.

Valley of the Big Ivy Creek.

B.	Dillingham's house, below Yeates' Knob, or Big Butte,	2568
B.	Junction of the three forks of Big Ivy,	2276
B.	Salomon Carter's house,	2215
B.	Stockville, at Squire Black Stocks',	2216
R.R.	Mouth of Ivy River, by Railroad survey,	1684

REGION OF THE GREAT BALSAM MOUNTAINS.

From Asheville to Mt. Pisgah.

		Height.
B.	Asheville courthouse,	2250
B.	Sulphur springs, the spring,	2092
B.	Hominy cove at Salomon Davis's,	2542
B.	Little Pisgah west,	4724
B.	Great Pisgah,	5757

Big Pigeon Valley.

B.	Forks of Pigeon at Col. Cathey's,	2701
B.	East fork of Pigeon, at Cap. Th. Lenoir's,	2855
B.	Waynesville, courthouse,	2756
B.	Sulphur spring, Richland Valley, at James Love's, Esq.,	2716
B.	Mr. Hill's farm, on Crabtree creek,	2714
B.	Crab Tree creek, below Hill's farm,	2524
B.	Cold Mountain,	6063

Chain of the Richland Balsam, between Richland Creek and Big Pigeon River.

B.	Richland creek, at E. Medford's,	2938
B.	E. Medford's farm, foot of Lickstone Mt.,	3000
B.	Lickstone Mountain,	5707
B.	Deep Pigeon Gap,	4907
B.	Cold Spring Mountain,	5915
B.	Double Spring Mt.,	6380
B.	Richland Balsam, or Caney fork Balsam divide,	6425
B.	Chimney Peak,	6234
B.	Spruce Ridge Top,	6076
B.	Lone Balsam,	5898
B.	Old Bald, head of Richland Creek,	5786

Chain of Westener Bald.

B.	Westener Bald North Peak,	5414
B.	" " " Pinnacle,	5692

Great Middle Chain of Balsam Mountains between Scott's Creek and Soco Creek.

B.	Enos Plott's farm North foot of chain,	3002
B.	Old Field Mountain,	5100
B.	Huckelberry Knob,	5484
B.	Enos Plott's Balsam first Balsam North End,	6097
B.	Junaleska, or Jones' Balsam N. Point,	6223
B.	" " S. End,	6055
B.	Rockstand Knob,	6002
B.	Brother Plott,	6246
B.	Amos Plott's Balsam, or Great divide,	6278
B.	Rocky-face,	6031
B.	White-Rock Ridge,	5528
B.	Black-Rock,	5815
B.	Panther-Knob,	5359
B.	Perry Knob,	5026

Valley of Scott's Creek.

B.	Love's Sawmill, on Richland Creek,	2911
B.	Maclure's farm " "	3285
B.	Road Gap head of Scott's Creek,	3357
B.	John Brown's farm, Scott's Creek Valley,	3049
B.	Bryson's farm,	2173
B.	John Love's Esq., farm,	2226
B.	Webster Courthouse,	2203

Valley of Tuckasegee and tributaries.

B.	Tuckasegee River and mill below Webster, near road to Qualla,	2004
B.	Junction of Savannah creek,	2001
B.	" " Scott's creek,	1977
B.	Quallatown, main store,	1979
B.	Soco River, ford to Oconaluftee,	1990
B.	Soco Gap, road summit,	4341
B.	Amos Plott's farm, in Jonathan's Creek Valley,	3084

		Height.
B.	Oconaluftee River, junction Bradley fork,	2203
B.	Robert Collins, Esq., highest house,	2500
B.	Junction of Ravens, and Straight forks,	2476
B.	Junction of Bunch's creek,	2379

CHAIN OF THE GREAT SMOKY MOUNTAINS.

North of Road Gap.

B.	Luftee Knob, head of straight fork of Oconaluftee River,	6232
B.	Thermometer Knob,	6157
B.	Ravens Knob,	6230
B.	Tricorner Knob,	6188
B.	Mt. Guyot, (so-named by Mr. Buckley), in Tennessee,	6636
B.	Mt. Henry,	6373
B.	Mt. Alexander,	6447
B.	Mt. Alexander, South peak,	6299
B.	The Three Brothers, highest or central peak.	5907
B.	The Thunderknob,	5682
B.	Laurel peak,	5922
B.	Reinhardt Gap,	5220
B.	Top of Richland Ridge,	5492
B.	Indian Gap,	5317
B.	Peck's peak,	6232
B.	Mt. Ocona,	6135
B.	Right hand, or new Gap,	5096
B.	Mt. Mingus,	5694

Group of Bullhead, Tennessee.

B.	Central peak or Mt. Leconte,	6612
B.	West peak, or Mt. Curtis,	6568
B.	North peak, or Mt. Safford,	6535
B.	Cross Knob,	5931
B.	Neighbor,	5771
B.	Master Knob,	6013
B.	Tomahawk Gap,	5450
B.	Alum Cave,	4971
B.	Alum Cave creek junction with little Pigeon River,	3848

Great Smoky Mountains, South of Road Gap.

B.	Road Gap,	5271
B.	Mt. Collins,	6188
B.	Collins Gap,	5720
B.	Mt. Love,	6443
B.	Clingmann's Dome,	6660
B.	Mt. Buckley,	6599
B.	Chimzy Knob,	5588
B.	Big Stone Mt. head of Forney Ridge,	5614
B.	Big Cherry Gap,	4838
B.	Corner Knob,	5246
B.	Forney Ridge peak,	5087
B.	Snaky Mountain,	5195
B.	Thunderhead Mountain,	5520
B.	Eagle Top,	5433
B.	Spence Cabin,	4910
B.	Turkey Knob,	4740
B.	Opossum Gap,	3840
B.	North Bald,	4711
B.	The Great Bald's Central Peak, near the Gap of Little Tennessee,	4922
B.	" " " South Peak,	4708
B.	Tennessee River, Hardin's,	899
B.	Chilhowee Mt. Summit road to Montvale Springs,	2452
B.	Montvale Springs Tennessee, Main Building,	1293

The numerous altitudes measured in the summer of 1860 during an exploration of two months not being ready for publication, will be given in another communication.

Princeton, New Jersey, January, 1861.

ART. XIV.—*On the Formation of Picramic Acid;* by M. CAREY LEA.

IT is to Mr. Aimé Girard that we owe the first isolation of picramic acid, and correct determination of its constitution. His views however of the circumstances under which it is formed do not altogether agree with the results of my observations, and I advert to them now, because his second paper contains a criticism on the results obtained by another chemist, which criticism I think depends upon an inexact view of the reactions.

In a paper published by Dr. Evan Pugh in Liebig's Annalen, he endeavored to establish the identity of picramic acid with Wöhler's nitrohæmatic acid. Mr. Girard, while he agrees with Mr. Pugh in his conclusions, rejects his experiments and reasonings as insufficient.

"This chemist, in fact" he says "proceeded exactly as Mr. Wöhler had done before I demonstrated the formation of picramic acid by means of sulphydric acid. His process consists in mixing picric acid with protosulphate of iron, boiling with excess of baryta, precipitating the soluble baryta salt with ammoniacal acetate of lead and *finally in decomposing the lead salt by sulphydric acid.* Now it is evident that under these circumstances, even supposing that the protoxyd of iron had not converted the picric acid to picramic, the sulphydric acid alone would have produced this reduction." *

At first sight this conclusion seems perfectly legitimate, so much so, that it is probable that no test by experiment was thought necessary. Had such been made it would have been ascertained that sulphydric acid *is wholly without power to reduce* picric acid whether free or in combination with lead, to picramic acid.

The fact appears to have been overlooked that sulphydric acid is quite incapable of producing this reaction either upon picric acid, or as far as my experiments go, upon any picrate. It is the alkaline sulphids that possess this power, and not free sulphydric acid, a circumstance which has not been noticed, in consequence of chemists operating on solutions of picric acid in alcohol to which excess of ammonia had been added. When sulphydric acid is passed through such a solution, sulphydrate of ammonia is formed and acts on the picric acid.

Sulphydric acid may be passed through solutions of picric acid, picrate of potash or picrate of ammonia, either at ordinary temperatures, or at a boiling heat, for any length of time, without producing the slightest effect. On the addition of excess of alkali the reducing effect of the sulphid formed is immediate.

Philadelphia, Nov. 30, 1860.

* Comptes Rendus, xlii, 59.

ART. XV.—*Remarks on a proposed Process for the Estimation of Nitrogen, and on an Acidimetric Process;* by M. CAREY LEA.

IN a late number of the London Chemical News* a modification of Will and Varrentrapp's process for the estimation of nitrogen is proposed by Mr. J. Walker. He decomposes the substance in a combustion tube in the ordinary way, but instead of conducting the products of the combustion into chlorhydric acid, conducts them into solution of chlorid of zinc, and in place of determining the ammonia in the usual manner, determines the amount of oxyd of zinc precipitated by it. "This process," the author observes, "has been practised by me for the last two years, and gives most accurate results, and I can with perfect confidence recommend it."

Few chemists would be apt to adopt a process so obviously worthless, but as its author recommends it especially for the analysis of manures, and as in that way it might be employed for technical purposes, it seems desirable that its gross inaccuracy should be pointed out. Oxyd of zinc is well known to be easily soluble in ammonia salts: if a drop of caustic ammonia is let to fall into a solution of pure neutral chlorid of zinc, it occasions a precipitate of oxyd, if now solution of sal-ammoniac be added, the precipitate redissolves. Obviously if more ammonia, instead of sal-ammoniac, is added, sal-ammoniac is formed by the decomposition of the zinc salt, and a portion of the precipitate is redissolved by it, or to speak more correctly, a portion of the oxyd of zinc which is liberated by the ammonia, is held in solution by the sal-ammoniac. The necessary result must be an under-estimation of the ammonia, leading to errors of such magnitude as would render the process wholly unfit even for the roughest technical process.

In consequence of overlooking the frequent solubility in alkaline solutions of certain metallic oxyds and basic salts insoluble in water, even chemists of experience have been led into singular errors. Dr. Friedrich Mohr in his interesting book on Volumetric Analysis, highly recommends a process proposed by Kieffer for acidimetric estimation, and which is briefly as follows. Sulphate of copper in solution is treated with liquid ammonia until the precipitate formed is nearly redissolved; it is then filtered, diluted to a certain strength and constitutes the test liquid. If this be dropped into an acid, or an acid solution, after the addition of a certain quantity a precipitate falls, the appearance of which Kieffer and Dr. Mohr consider to mark the moment

* Nov. 24, 1860, p. 280.

of the exact saturation of the acid liquid by the joint action of the ammonia and copper. Dr. Mohr observes:*

"Donc le moindre excès de la liqueur de dosage formera un précipité bien net, tout à fait insoluble dans la dissolution des deux sels complétement neutres."†

Here is an important error, this precipitate is by no means insoluble in such solutions, it is soluble with considerable facility in solution of sulphate of ammonia (in the above passage Dr. Mohr refers more particularly to the dosing of sulphuric acid) and also, though to perhaps not to so great an extent, in solutions of sal-ammoniac and of nitrate of ammonia. Consequently when the precipitate appears, it is because the solution is saturated with it. If it were not that the effect of the cupro-ammoniacal solution is directed to be determined empirically and not by calculation, this solubility would have led to discrepancies no doubt sufficiently great to have awakened suspicion. But the error is just sufficiently great to make the process dangerous. More or less of the precipitate is held in solution according as the saline solution is more or less dilute. Consequently if the liquid to be analyzed contains no saline matter, the error may be but trifling, the error in the analysis correcting more or less accurately the original error in the determination of the "titre." This mode of estimation is particularly recommended for determining the quantity of free acid in acid saline solutions, but here is just where it would be most fallible, the nature and quantity of the saline substance in solution exerting a powerful influence on the solubility of the precipitate. It is evident that a solution containing 5 grammes of free sulphuric acid with 5 grammes of sulphate of ammonia, tested in this way, would give quite a different result from one in which 5 grammes of free acid was contained with 20 or 50 of sulphate of ammonia. Likewise its results when used in the "method of residues" must be false. Accordingly in an experimental trial by Dr. Mohr‡ for the determination of magnesia by supersaturation with a known quantity of sulphuric acid, and determination of the residue of uncombined acid, the result which he obtained is erroneous by 4 per cent. Four per cent too little of magnesia were obtained, because the free sulphuric acid was over-estimated, the ammonio-cupric solution having been added till a precipitate was obtained, which as we have just seen, does not fall till *after* the saturation point has been reached.

The precipitate which appears in all these cases is spoken of by Dr. Mohr as hydrated oxyd of copper. It appears to be basic (probably quadrobasic) sulphate.

* Not having a German copy at hand I quote from the French translation made by Forthomme under the superintendence of Dr. Mohr.

† Forthomme's translation, p. 409.

‡ Op. cit., p. 412.

In making these observations on a single process of Dr. Mohr, I wish at the same time to bear testimony as to the candor with which he has given the results of his experimental trials. The proposal of a mode of analysis such as that of Mr. Walker is a new proof how much it is to be regretted that any chemist should offer a new mode of analysis, without having first controlled it by the analysis of one or more specimens of substance of a known composition. In this way MM. Glénard and Guillermond have recently proposed* a method of estimating the quinine in barks. It has been however shown† that not only the presence of cinchonine destroyed the accuracy of these results, but that owing to a mistake of the authors as to the reaction of the sulphates of quinine upon tincture of logwood, the process when performed with pure quinine gave only one-half the true result.

In connection with the foregoing observations on zinc I may remark that an error has crept into the description of zinc reactions in Gmelin's Handbook. It is there stated that zinc salts give precipitates with ferrocyanid and ferridcyanid of potassium, both of which are soluble in chlorhydric acid.‡ As respects the precipitate with ferrocyanid, this is certainly erroneous, the precipitate does not redissolve in that acid.

Philadelphia, Dec. 28, 1860.

ART. XVI.—*On the Dimorphism of Arsenic, Antimony and Zinc*; by JOSIAH P. COOKE, JR.

THE rhombohedral forms of arsenic, antimony and zinc are well known. Those of arsenic and antimony have been determined by several observers,§ and that of zinc first observed by Nöggerath,‖ on a furnace product from the smelting works of the Vieille Montaigne Zinc Co., near Aix la Chapelle, was subsequently redetermined on the same specimen by Gustav Rose.¶ It is the object of the present paper to show that these elements may also crystallize in regular octahedrons and therefore that they are dimorphous. Supposed monometric crystals both of arsenic and zinc have been previously described but since these observations have been discredited, the author has thought it best to publish his results.

Arsenic.—In the "Journal für praktische Chemie," vol. xxii, 344, 1841, Elsner describes, as crystals of arsenic, octahedrons,

* Rep. de Chimie Appliquée, 1859, p. 131. † Idem, 1860, p. 61.

‡ Handbook, vol. v, p. 12, Cavendish edition.

§ See description of a crystal of rhombohedral arsenic, in Proceedings of American Academy of Arts and Sciences, vol. iii, 86.

‖ Poggendorff Annalen, vol. xxxix, 323. ¶ Ibid., lxxxiii, 129.

which he obtained by subliming a mixture of arsenious acid and charcoal powder. The author repeated the experiment of Elsner and obtained very distinct octahedral crystals, having a nearly black color and bright lustre, which were undoubtedly the same as those observed by Elsner. Similar crystals made by subliming the commercial arsenic, "cobalt," in a glass flask were at first sight mistaken by the author for crystals of arsenic. Their true nature however became evident on boiling the crystalline mass in water when it all dissolved with the exception of a small quantity of a black amorphous powder, the amount varying with different specimens. The substance dissolved was easily recognized as arsenious acid, and the black powder as finely subdivided metallic arsenic. The octahedrons were evidently merely crystals of arsenious acid containing as a mechanical mixture, particles of metallic arsenic like the sand in the crystals of Fontainbleau limestone. This result led the author to make a series of experiments with a view of testing the possibility of crystallizing pure metallic arsenic in forms of the monometric system. In one experiment rhombohedral crystals of arsenic, which had been prepared by sublimation in the usual way, afterwards kept under water, deprived of air by boiling, and just before using dried in a current of hydrogen, were introduced into a glass flask. Through this flask which was fitted with a cork and glass tubes for the purpose, a gentle current of hydrogen was maintained, the gas entering at the top and passing out near the bottom of the flask. As soon as the flask was known to be filled with hydrogen, the arsenic was sublimed in this atmosphere, when it condensed around the neck forming the well known metallic mirror. On subsequently breaking the flask and examining the mirror with a microscope (power of eighty diameters) it was found to be studded with distinct octahedral crystals having a greyish color and a bright metallic lustre. These octahedrons were recognized as belonging to the monometric system first by measuring the angles of the triangular faces and finding that they were equilateral triangles, second by the general "habitus" of the crystals especially in their distorted forms which could never be mistaken for truncated rhombohedrons, the only form with which they were liable to be confounded. The crystals were strictly microscopic and could not be distinguished with a pocket lens except as brilliant points. The precautions taken in the preparation seemed to exclude the possibility of any arsenious acid being present, but in order to establish this fact beyond a doubt, a portion of the metallic crust studded with the crystals was boiled in water for several minutes and afterwards treated with the strongest aqua ammoniæ for twenty-four hours, but the crystals were not dissolved by either reagent nor was their sharpness apparently impaired.

In another experiment arseniuretted hydrogen gas was reduced in a bohemian glass combustion tube in the usual way, when testing for arsenic only on a larger scale and with special precaution in order to ensure the exclusion of air from the apparatus, and to regulate the quantity of arseniuretted hydrogen in the current of hydrogen gas. To one end of the combustion tube was connected by a cork a small exit tube whose open end dipped under mercury the other end was connected by means of a tube having two branches each provided with a stop-cock with a hydrogen generator on the one hand and on the other with a gas bottle generating arseniuretted hydrogen. The last was provided with a safety tube by which the excess of gas not needed in the experiment might escape. Before heating the combustion tube it was filled with hydrogen from the generator by which a uniform current of gas through the tube was maintained during the process. A portion of the tube two or three inches long was next heated to a red heat and then by opening the stop-cock a very small amount of arseniuretted hydrogen was allowed to mix with the hydrogen current and the experiment continued until a metallic mirror was formed on the glass beyond the heated portion of the tube. This mirror examined by the microscope, was found to be studded with minute octahedral crystals, which were submitted to the same test as before and with the same results.

Antimony.—No crystals of this metal except the well known rhombohedral forms ever appear to have been observed. Hauy formerly supposed that he had discovered in antimony the four cleavage planes of the regular octahedron and the six cleavage planes of the regular rhombic dodecahedron, but his observations were made on the ordinary regulus of antimony, which is now known to have rhombohedral cleavages. After crystallizing arsenic in octahedron by the process last described the author succeeded in obtaining octahedral crystals of antimony with the same apparatus, using antimonuretted hydrogen in place of arseniuretted hydrogen. The tube was heated with a Bunsen's gas burner to as high a temperature as it was capable of yielding and the process conducted as before. On breaking the tube and examining the metallic mirror with a microscope it was found studded with minute octahedral crystals. They were more readily obtained than the corresponding crystals of arsenic and presented the same characteristic forms. The solid angles of the octahedrons were very frequently observed modified by the faces of the cube and in one case at least the edges were truncated by the faces of the rhombic dodecahedron. These modifications are of importance as they remove all doubt in regard to the system of crystallization. The crystals being microscopic their interfacial angles could not of course be measured, but the

existence of these modifications is even more satisfactory evidence on this point than an actual measurement.

It is well known that oxyd of antimony is capable of crystallizing in octahedrons belonging to the monometric system and although from the construction of the apparatus it was deemed impossible that any sensible amount of air could become mixed with the hydrogen in the tube, yet in order to remove all doubt on the subject, the crystals were exposed to the following reagents.

A portion of the glass tube covered with crystals was first boiled for a long time in water and subsequently treated with the strongest liquid hydrochloric acid; but although exposed to the action of the acid for several days in a warm room, the crystals were not dissolved. They also resisted for some time the action of boiling hydrochloric acid, but after prolonged boiling they disappeared. Exposed to the action of chlorine gas at a very gentle heat, the crystals were immediately consumed, leaving no residue and rendering the gas cloudy from the fumes of chlorid of antimony. Lastly, a portion of the tube (on which was deposited nothing but distinct octahedral crystals), was treated with a few drops of nitric acid, and a gentle heat applied. The crystals were at once attacked and the familiar white powder of antimonious acid was the result. This dissolved on adding a few drops of hydrochloric acid and the solution evaporated nearly to dryness, diluted with a solution of tartaric acid and subsequently treated with a solution of sulphid of hydrogen, gave the familiar red precipitate of sulphid of antimony.

In the metallic mirrors of arsenic and antimony obtained by Marsh's test, the metals seem to be always in the octahedral modification, and when deposited slowly are more or less crystalline. The author has obtained the best crystals by resubliming the metallic mirrors, after they were first formed, in a slow current of hydrogen, and it is in this way very easy to obtain the crystals entirely isolated on the surface of the glass tube, and in the case of antimony the author has traced with the microscope every gradation between the distinct crystals and the granular coating, which forms the mass of the mirror. The process of crystallization in the formation of the mirror is similar to that of salammoniac on a glass plate and the lines of crystals shoot out in the same way parallel to the axis of the tube.

Zinc.—In the "Annales de Chimie et de Physique," vol. xxii, 37, 1848, Nicklès has described some crystals of pure zinc prepared by M. Favre with the process of M. Jacquelain as pentagonal dodecadrons but unfortunately he has given no measurement of angles to confirm his opinion. This observation has been questioned by Gustav Rose* on the grounds first that the

* Poggendorff, Annalen, vol. lxxxv, 293.

mamillary concretions of zinc, which are frequently deposited on the cooler portion of the retort during the process of distillation might readily be mistaken for pentagonal dodecahedrons without any exact measurement of angles, and secondly that this form which is characterized by a peculiar law of symmetry, has never, been observed unless this case is an exception, on any metallic crystals. The question might readily be settled by a reëxamination of the original specimen and it is to be hoped that, if they still exist, such an examination will be made.

In "Poggendorff's Annalen," vol. cvii, 441, 1859, Gustav Rose has described two specimens of crystallized brass formerly belonging to the mineral collection of Klaproth, which show in the cavities of the mass distinct crystals. Rose infers that these crystals belong to the monometric system rather from their grouping as indicated by the striation than from the external forms of the individual crystals which was too indistinct to admit of exact determination. This subject has been much more fully studied by Mr. F. H. Storer in the laboratory of Harvard College. Storer obtained octahedral crystals composed of zinc and copper in the varying proportions of the constituents from pure copper to 70 per cent of zinc.* The crystals were made by fusing the metals in a crucible and pouring out the still liquid alloy after a crust had formed on the surface as in crystallizing bismuth or sulphur. They were all too ill-defined to admit of direct determination and although they exhibited similar striations to those described by Rose, the striæ did not seem to the author to fix the system of crystallization with such clearness as to exclude all doubt. There were however other circumstances which were thought to point out the system of the crystals; first, the crystals resembled precisely the artificial crystals of magnetic oxyd of iron which are frequently obtained as a furnace product, and which are known to belong to the monometric system. The author had recently the opportunity of comparing with the brass crystals a very finely characterized specimen of this magnetic oxyd in the mineral collection of Dr. Krantz at Bonn. Second, the whole series of crystals including those of pure copper had the same characters and if the crystals of copper were monometric, as no one will question, the rest are also. But assuming that the octahedrons in question are monometric, this fact has no bearing upon the crystallizing form of zinc unless it can be also shown that there is no definite chemical combination between the zinc and the copper, or in other words, that the alloys of those metals are nearly isomorphous mixtures. Storer has proved this point as the author thinks, conclusively, by analyzing the series of crystals as well as the alloys in which they were formed. The full details of his results will be found in his

* See an abstract of Storer's paper at the close of this Number.

memoirs in vol. vi, of the Memoirs of the American Academy of Arts and Sciences. It is sufficient for the present purpose to state that the composition of the crystals was in every case sensibly the same as that of the alloy.

This investigation seems to prove that zinc is capable of assuming a monometric condition and thus of crystallizing in connection with copper in the same way that sulphate of copper may be made to crystallize in connection with sulphate of iron, taking the form of green vitriol although it generally assumes the form of another system. But although his results are conclusive as far as they go, Storer could not obtain crystals containing more than 70 per cent of zinc. The alloys of zinc and copper containing more than this per cent of zinc become granular on cooling, and do not yield distinct crystals. The following observations of the author may therefore be of value in extending the history of the subject.

During the course of some experiments on the compounds of zinc and arsenic a furnace product was accidentally obtained composed of these two elements imperfectly fused together and mixed with cinders. The cavities of this mass were lined with very brilliant octahedral crystals having a bright metallic lustre. The crystals although small could be easily measured with a reflective goniometer and gave the exact angle of the monometric octahedron. A sufficient number of the crystals for analysis was separated with some difficulty from the gangue. They were dissolved in dilute hydrochloric acid and the zinc precipitated with carbonate soda was determined in the usual way. The result gave

Zinc,	81·18
Arsenic,	18·82
	100·00

The quantity of arsenic in these crystals is so much smaller than the amount required to form any probable definite compound that there can be but little doubt that it is present as impurity and that the octahedrons are an isomorphous mixture of the two elements. The presence of a certain amount of impurity seems to favor metallic crystallization and it is possible that it may be the disposing cause in this case, inducing as it were a monometric condition in the zinc. The beautiful lead crystals containing a small quantity of antimony which are obtained at the smelting works near Clausthal in the Harz, are familiar to mineralogists, and the author has found that a small quantity of lead on the other hand greatly facilitates the crystallization of antimony. Similar facts have been noticed in the case of bismuth so that distinct crystallization instead of being the test of purity in the case of a metal is quite the reverse. To what extent the presence of these impurities may effect the crystalline form of the metal

has not yet been determined but it is certain that this influence is important and that it depends as well on the amount as on the nature of the impurity. Laurent and Holms (Ann. de Chimie et Phys., [2], vol. lx, 333), state that zinc containing a few per cent. of iron crystallizes in rhombic prisms, and Warren de la Rue also (Philosophical Magazine, vol. xxvii, 370) has analyzed and measured rhombic prisms of zinc having the composition, zinc 90·00, iron 2·56, lead 6·00, copper 1·44. Acicular crystals having a similar composition have also been described by Erdmann, (Berzelius, Traité, ii, 620). Moreover the author observed in a furnace product similar to the one above described some flexible acicular crystals which he analyzed and found to consist of zinc 91·3, arsenic 8·7. These crystals could not be crystallographically determined but they were undoubtedly similar in form to those before described and entirely different from the octahedral crystals noticed above. Is it not possible that all the prismatic crystals of zinc, which have been described, including those of Nöggerath and Rose, may belong to the same crystalline system? If so the apparent anomaly presented by the above facts would disappear, and as the observers themselves do not claim that the crystalline system has in either case been determined beyond a doubt, this is not an improbable supposition; moreover the authority for the rhombohedral system rests on a single specimen, which, as Rose admits, is not capable of exact determination crystallographically and has never been analyzed. However these facts may be regarded, the octahedral crystals above described appear to the author to confirm the view that zinc is capable of crystallizing in the monometric system, but he does not attach to the observation any weight except as confirming previous results, and as furnishing additional data for the solution of the problem.

Cambridge, Nov. 14, 1860.

ART. XVII.—*General Account of the Results of Part* II. *of the discussion of the Declinometer Observations made at the Girard College, Philadelphia, between* 1840 *and* 1845, *with special reference to the Solar Diurnal Variation and its Annual Inequality;* by A. D. BACHE, Superintendent U. S. Coast Survey.

(Read before the Amer. Assoc. for the Adv. of Science, at Newport.)

THE discussion presented last year to the Association embraced the amplitude of the solar diurnal magnetic variation, as well as that of the number and magnitude of the disturbances of declination, in reference to the eleven years' period, heretofore pointed out by General Sabine and others. The discussion now presented, is of the annual solar diurnal variation and its annual

inequality. The complete results of the computations, as in the other case, will be given in the Smithsonian Contributions to Knowledge, and the present paper will contain merely a general account of the results.

The normals, or means, freed from the disturbances, are used in the discussion, avoiding thus the necessity for rejecting the observations of months in which disturbances are frequent. The same course is followed by the Rev. Professor H. Lloyd in his discussion of the Dublin observations and also by General Sabine in the third volume of the discussion of the Toronto observations. I therefore return to the hourly normals given in part (I.)* of the discussion, and arrange them according to months of the year, correcting those of 1845 for index error, as already explained. The tables given in the complete memoir, show at one view the mean hourly readings for each month unaffected by large disturbances, and the mean hourly position of the magnet in reference to its general mean position. The solar diurnal variation for each month is readily traced in the table, but the annual inequality in the diurnal variation being affected by the secular changes is less distinctly traceable. To give this result distinctness, each hourly normal is compared with the corresponding monthly mean value, as set down in the last vertical column of the table, and the results are recorded in a new table. The sign + in this latter table indicates a westerly, and the sign − an easterly deflection of the north end of the magnet from its mean position, the scale divisions having been converted into minutes of arc.

The distinctive features of this second table are brought out both analytically and graphically. The inequality in the diurnal variation is most readily seen by comparing the horizontal lines of the table from August and February and the annual variation appears most plainly by carrying the eye down the vertical columns for the hours of 6 and 7 A. M.

The annual variation depends upon the earth's position in its orbit, the diurnal variation being subject to an inequality depending upon the sun's declination. The range is greater during the summer, when the declination is north, and less during the winter when the declination is south, and passes from one to the other about the time of the equinoxes. The summer and winter means are therefore tabulated for comparison with the general mean. Diagram A shows the type curve for the summer and winter periods and the general mean of the year. The summer months, April to September inclusive, give a diurnal range of nearly 10½ minutes and the winter months one of 5½ minutes. Diagram B shows the same results in a different form, the mean yearly curve of the first diagram (A) being straightened out to form the axis of the second (B). The curves represent the win-

* This Jour., [2], vol. xxix, p. 36.

ter and summer variations, the ordinates being the difference between those of the yearly curve, and of the winter and summer curves respectively. This diagram shows very perspicuously the progress of the annual variation at different hours of the day. It shows that at 6 or 7 A. M. the annual variation is a maximum, disappearing at a quarter before 10 A. M. That it reaches a second, (secondary,) maximum at 1 P. M. nearly disappearing shortly after 5 P. M. A still smaller maximum is reached after 9 P. M. and half an hour before midnight the annual variation again disappears. At, and before, and after the principal maximum between 6 and 7 A. M. the annual variation causes the north end of the magnet to be deflected to the eastward in the summer and to the westward in the winter. At 1 P. M. the deflections are to the west in summer and to the east in winter; the range of diurnal motion being thus increased in the former season and diminished in the latter. The needle is thus deflected in summer, more to the east in the morning hours and more to the west in the afternoon hours, or has greater elongation than it would have if the sun moved in the equator. In winter the reverse is the case. The range of annual variation from summer to winter at Philadelphia is about 3′, and its daily range about 2′·6.

In diagram C similar curves are given for Philadelphia, St. Helena, Toronto and Hobarton, of the winter and summer progress of the annual variation. The comparison indicates that Toronto and Hobarton are not normal types of the half yearly deflections and the near coincidence of the forms at Philadelphia and St. Helena, seems to show that the type for different places is one and the same in general character, affected by incidental irregularities.

In reference to the annual variation, Gen. Sabine, in the rectifications and additions to the last volume of Humboldt's Cosmos, expresses himself as follows:

"Thus in each hemisphere the semi-annual deflections concur with those of the mean annual variation for half the year and consequently augment them, and oppose and diminish them in the other half. At the magnetic equator, there is no mean diurnal variation, but in each half year the alternate phases of the sun's annual inequality constitutes a diurnal variation of which the range in each day is about 3′ or 4′, taking place every day in the year, except about the equinoxes, the march of the diurnal variation being from east in the forenoon to west in the afternoon when the sun has north declination and the reverse when south declination." According to the same authority the *annual* variation is the same in both hemispheres, the north end of the magnet being deflected to the east in the forenoon, the sun having north declination, whereas in the *diurnal* variation the north

end of the magnet at that time of the day, is deflected to the east in the northern hemisphere and to the west in the southern; In other words, in regard to direction, the law of the annual variation is the same as that of the diurnal variation, but opposite in passing from the northern to the southern magnetic hemisphere.

Some interesting conclusions as to the law of change of the annual variation, will flow from a closer discussion of the observations at the two hours of maximum, namely 6 to 7 A. M. and 1 to 2 P. M. The general table, by subtracting the annual mean from each monthly value, at the respective hours, gives the following values for the annual variations at or near the hours of principal and secondary maxima of range, the signs + and − indicating as usual westerly, or easterly deflection from the annual mean position.

	6 to 7 A. M.	1 to 2 P. M.		6 to 7 A. M.	1 to 2 P. M.
January,	+2′·01	−0′·98	July,	−1′·94	+1′·25
February,	+1·31	−1·12	August,	−2·66	+1·31
March,	+0·47	−0·47	September,	−1·24	+0·82
April,	+0·15	+1·06	October,	+1·41	−1·14
May,	−1·38	+0·93	November,	+1·47	−1·35
June,	−1·90	+0·89	December,	+2·30	−1·20

The greatest range at 6 to 7 A. M. is 5′·0 the easterly deflection being greater than the westerly by 0′·4. That from 1 to 2 P. M. is 2′·7, the eastern and western deflections being equal. A general inspection of the columns shows that the solstices are approximately the turning epochs of this annual variation, and that the signs change at the time of the equinoxes. To determine these points with the more precision the numbers of the table were expressed by an analytic formula. According to this, January 1st and July 1st (ten days after the solstices) are the dates of the greatest values, and the transition from positive to negative values, and the reverse will occur on the first of April and first of October (ten days after the equinoxes).

A table is given in the memoir showing the satisfactory coincidence of the observed and computed values. This result agrees with that deduced by a different method by General Sabine.

To give a definite determination of the law of the phenomenon, so as to embrace the whole progress shown by the series, the regular solar diurnal variation has been expressed as a function of the time, by four terms of Bessel's formula, the equation being found for each month, and also for each half year from April to September and from October to March and also for the whole year. Allowance was made in determining the coefficients for the different weight of the readings at the even and at the odd hours.

The equation for the whole year is compared with that given by Prof. Lloyd for Dublin. Reference is made to the monthly equations deduced by Mr. Karl Kreil from a consecutive series of observations made at Prague from 1840 to 1849, and selected from a longer series of thirteen years.

The following table exhibits the close correspondence of the computed and observed mean annual value of the regular solar diurnal variation.

Philadelphia mean time.	Diurnal variation. Compared.	Observed.	Difference.	Philadelphia mean time.	Diurnal variation. Compared.	Observed.	Difference.
h m	′	′	′	h m	′	′	′
0 19½	−0·49	−0·47	−0·02	12 19½	+3·69	+3·65	−0·04
1 "	−0·48	−0·51	+0·03	13 "	+4·28	+4·32	+0·04
2 "	−0·51	−0·44	−0·07	14 "	+3·81	+3·77	−0·04
3 "	−0·67	−0·71	+0·04	15 "	+2·77	+2·76	−0·01
4 "	−1·09	−1·19	+0·10	16 "	+1·71	+1·80	+0·09
5 "	−1·82	−1·64	−0·18	17 "	+0·88	+0·78	−0·10
6 "	−2·77	−2·72	−0·05	18 "	+0·33	+0·25	−0·08
7 "	−3·49	−3·47	−0·02	19 "	−0·07	−0·07	−0·00
8 "	−3·44	−3·50	+0·06	20 "	−0·38	−0·33	−0·05
9 "	−2·29	−2·43	+0·14	21 "	−0·57	−0·60	+0·03
10 "	−0·24	−0·19	−0·05	22 "	−0·62	−0·64	+0·02
11 "	+2·03	+2·17	+0·14	23 "	−0·57	−0·71	+0·14

The greatest difference at any one hour is less than 11″ and the probable error of any single computed value is ±0′·19.

Diagrams D and E give the resulting curves for the computed hourly values of the diurnal variation for each month of the year. Diagram D contains the curves for the six months of the summer half year and E, for six months of the winter half year. Positive ordinates correspond as before to a westerly motion of the north end of the needle, and negative ordinates to an easterly motion. Diagram F contains the type curves for the summer, winter and the whole year.

From the computed values as given in the the table assisted by the diagrams, the general features of the diurnal variation and of its annual inequality are readily deduced.

The general character of the diurnal motion is nearly the same for the summer half year, for the winter half and therefore for the whole year. The greatest eastern deflection is, at a mean, reached a quarter before eight A. M. being a quarter of an hour earlier in summer, and half an hour later in winter. Near this hour the declination is a minimum. The greatest western deflection is reached, at a mean, at a quarter after one o'clock P. M., a few minutes earlier in both the summer and winter. At this hour the declination is a maximum. The diurnal curve presents but a single wave, slightly interrupted by a deviation occurring during the hours near midnight, or from 10 P. M. to 1 A. M. when the magnet has a direct or westerly motion. Shortly after 1 A. M. the north end of the magnet moves easterly, completing the

cycle, and arriving at its eastern elongation shortly before 8 A. M. This nocturnal deviation is well marked in winter, vanishes in summer and is but slightly perceptible in the annual curve. According to the investigations of General Sabine, it is probable that if the effect of disturbances was completely obliterated in the results, this small oscillation would disappear. In summer when it is not noticed the needle remains nearly stationary from 8 P. M. to 3 A. M. The type curves for the year, show a similar result. The diurnal curves for the months when the sun's declination is north, and those when it is south, resemble each other closely, as is shown by diagrams D and E.

For greater precision in regard to the epoch and amount of the diurnal variation we must recur to the analytical expressions representing the numbers of the table.

The following table contains the results for each month and for the summer and winter seasons and the whole year, also the critical interval between the two adjacent hours of the mean positions.

Month.	Eastern elong. A. M.	Western elong. P. M.	Critical interval from min. to max.	Epoch of mean declination. A. M.	Epoch of mean declination. P. M.	Critical interval.
	h m	h m	h m	h m	h m	h m
January,	8 58	1 27	4 29	10 52	7 08	8 16
February,	8 34	1 32	4 58	10 52	7 26	8 34
March,	8 07	1 34	5 27	10 46	7 32	8 46
April,	8 12	1 27	5 15	10 34	7 40	8 56
May,	7 29	1 21	5 52	10 19	6 57	8 38
June,	7 33	1 20	5 47	10 25	8 26	10 01
July,	7 36	1 28	5 52	10 30	9 32	11 02
August,	7 18	1 05	5 47	10 10	8 40	10 30
September,	7 30	0 45	5 15	9 58	6 45	8 47
October,	8 00	1 17	5 17	10 30	5 23	6 53
November,	7 54	1 08	5 14	10 16	6 08	7 52
December,	8 54	1 40	4 46	10 50	6 17	7 27
Summer,	7 33	1 08	5 35	10 17	7 43	9 26
Winter,	8 24	1 25	5 01	10 40	6 49	8 09
Year,	7 48	1 16	5 28	10 26	7 08	8 42

The formulæ also give for the time of the seondary minimum of eastern declination in winter $9^h\ 42^m$ P. M. and for its amount $-0'{\cdot}97$.

For the time of the secondary maximum of western declination in winter, $1^h\ 15^m$ A. M., and for its amount $-0'{\cdot}26$; differences $3^h\ 33^m$ and $0'{\cdot}71$.

For the secondary minimum of eastern deflection for the year, $10^h\ 11^m$ P. M. and its amount, $-0'{\cdot}62$.

For the secondary maximum of western deflection for the year, $1^h\ 13^m$, and its amount $-0{\cdot}47$; differences $3^h\ 02^m$ and $0'{\cdot}15$.

The effect of the season on the critical hours is well marked in the foregoing table, the eastern elongation occurring earliest between the summer solstices and the autumnal equinox, and latest about the winter solstice.

The eastern elongation occurs earliest about the winter solstice and the same holds good for the morning epoch of the mean declination. The afternoon epoch, however, occurs earliest shortly after the autumnal equinox, and latest shortly after the summer solstice. The critical hours which are most constant during the year, are those of the western elongation and of the morning mean declination. The greatest difference between any month and the mean of all the months, is 31 minutes in the former and 28 in the latter.

To exhibit the features of the diurnal variation and its annual inequality, a graphical representation is given in diagram G. The magnetic surface is formed by contour lines 0′·5 apart. The curves in dots (....) are lines of mean position. Those in dashes (- - - -) are eastern deflections from the normal position and the full lines are western deflections. This Diagram and the table from which it is deduced are immediately applicable to the practical problem of furnishing the correction to be applied to a single observation, made at any hour of the day and month, to reduce it to its mean value. It also renders unnecessary the development of the annual variability of the coefficients in the analytical expression. The diagram distinctly exhibits the diurnal minima and maxima, the former represented by a valley, the latter by a ridge, on the magnetic surface.

Next, the magnitude of the diurnal range is studied. The following table exhibits the amount of the deflection at the eastern and western elongation and the diurnal amplitude of the declination for each month in the year derived from the equations.

	Deflection at		Diurnal		Deflection at		Diurnal
	E. Elong.	W. Elong.	range.		E. Elong.	W. Elong.	range.
Jany.	−2′·46	+3′·52	5′·98	July.	−5′·58	+5′·46	11′·04
Feby.	−2 ·64	+3 ·11	5 ·75	Aug.	−5 ·79	+6 ·36	12 ·15
March.	−3 ·73	+4 ·03	7 ·76	Sept.	−4 ·71	+5 ·60	10 ·31
April.	−4 ·02	+5 ·28	9 ·30	Oct.	−2 ·18	+3 ·23	5 ·41
May.	−4 ·89	+5 ·16	10 ·05	Nov.	−1 ·92	+2 ·85	4 ·77
June.	−5 ·26	+5 ·06	10 ·32	Dec.	−1 ·65	+3 ·14	4 ·79

The diurnal range for the summer months is 10′·45, for winter months 5′·56, and for the whole year 7′·89, all corresponding to an epoch about a year and a half removed from the epoch of a minimum of the solar period.

The numbers denoting the diurnal range, exhibit three remarkable features, namely, the maximum value in August, the sudden falling off in September and October, (Diagram H,) and the minimum value in November and December. In other respects, the progression is regular. The curve is single crested, which holds in the eastern, as well as the western deflections when viewed separately. This is of special importance, as it is probable that the interference of these separate curves at other

stations chiefly determine the double crested character of the curves of diurnal range. The curves for Milan, Munich, Göttingen, Brussels, Greenwich, Dublin, etc., for instance, exhibit two maxima, one after the vernal equinox and a second, generally the smaller, about the summer solstice. The system to which Philadelphia belongs, is exemplified by the annual progress of the diurnal range at Prague and certain Russian stations, as at Nertschinsk, but more closely by Toronto as seen in Diagram H. Neither station appears to have a tendency to a secondary maximum about the month of April, so that the maximum about a month and a half after the summer solstice, is a well marked feature of the North American stations.

In connection with the preceding discussion the inequality in the magnetic declination from year to year next claims attention.

This subject presents greater inherent difficulties than the diurnal inequality, on account of the difficulty of keeping the instrument in precisely the same condition of adjustment throughout the year. In the first part of the discussion, I had occasion to refer to this circumstance while investigating the annual effect of the secular change, and it was then shown that the Philadelphia observations share in this respect a similar difficulty with other stations in consequence of which the results must be received with caution.*

In the mean monthly values of the declinometer readings and in their differences, when compared month for month, are combined the joint effect of the secular change, and of the annual inequality. To eliminate the effect of the secular change, conditional equations were formed, which give a value deduced by the application of the method of least squares, of 1·227 divisions, as the monthly effect of the secular change.† The effect of the secular change was deduced from the mean monthly values, and these values themselves being subjected to certain corrections, which the numbers show to be necessary, the following result for the annual inequality was obtained.

* Dr. Lloyd's instructive note on this subject in his discussion of the Dublin observations is as follows: "The determination of the annual variation is much more difficult than that of the diurnal, both on account of the much smaller frequency of the period and the difficulty of preserving the instrument in the same unchanged condition during the much longer time, or of determining and allowing for its changes when they do occur; accordingly, although the annual period may be traced in the observations of Gilpin and is decidedly displayed in those of Bowditch, it has evaded the researches of recent observers. There is but a faint indication of its existence in the Göttingen observations, which were made at the hours of 8 A. M. and 1 P. M., and Prof. Gauss and Dr. Goldsmith, find in the analysis of these observations no important fluctuations dependent upon season. A similar negative result is deduced by Dr. Lamont from the Munich observations which were made twelve times a day.

† This value 6′·7 of annual change, though not preferable to the value (4′·5) deduced by a different method in part I of this discussion, must necessarily be employed in the present investigation. The most reliable value 5′·0 was deduced from independent observations, as already announced.

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean declinom. readings,	56[illegible]	563·1	563·5	562·6	561·1	[illegible]2·2	562·1	561·2	558·4	558·1	554 6	554·4
Corr. for secular change,	−4·4	−3·6	−2·8	−2·0	−1·2	−0 4	+0·4	+1·2	+2·0	+2·8	+3·6	+4·4
Annual variation in arc,	+0′·5	+0·4	−0·1	−0·1	+0·2	−0·6	−1·0	−0·9	0·0	−0·2	+0·9	+0·7

This result has been adopted as representing the annual variation. From June to October the north end of the magnet is accordingly to the eastward of the mean annual position, (after the elimination of the secular change,) and in the remaining months of the year, it is to the westward of this position. From the vernal equinox until after the summer solstice, the motion is to the eastward, or retrograde in regard to the advance of the secular change, (to the westward). This is in conformity with the law given by Dr. Lloyd in the Dublin discussions, the motion of the magnet there being to the westward at that period of the year, or the reverse of the Philadelphia deflection. The secular change is also reversed. The west declination diminishing at Dublin between 1840 and 1843. The results for annual inequality from seven years of observation at Toronto, are also brought out and compared with the Philadelphia results. The secular change at Toronto was 2′0, whilst at Philadelphia (1843) it was 4′4. In regard to the amount of the inequality, the two stations agree remarkably well, the range remaining slightly below 2′ of arc. It is supposed that this range at the same station is increasing, or diminishing, as the secular change increases or diminishes.

ART. XVIII.—*The Upper Silurian Beds of Western Tennessee; and Dr. F. Roemer's Monograph;* by Prof. J. M. SAFFORD, Lebanon, Tenn.

TO no part of Tennessee has the attention of American palæontologists been more frequently directed than to the region of "the glades," in the western part of the State. Recently attention has again been called to this region by the publication of Dr. Roemer's valuable and elegant monograph.* For this work, which we welcome with great pleasure, we are much indebted to Dr. Roemer. It presents a unique local fauna of great interest. Setting aside a few forms, the species he enumerates and describes belong to a bed of calcareous shales and limestones equivalent to the Niagara group of New York. This bed I have denominated for some time past, in my unpublished notes, the 'sponge-bed,' or the sponge-bearing bed, the appropriateness of which name is at once seen by referring to Dr. Roemer's monograph.

* Die Silurische Fauna Des Westlichen Tennessee; Eine Palæontologische Monographie von Dr. Ferdinand Roemer; Breslau, 1860. See this Journal, xxxi, 127.

The object of this article is to point out the fact that the fauna illustrated in the above work is not the only one occurring upon the glades. Heretofore not a little confusion has existed with reference to the different beds of this region. To this day, so far as the writer knows, no complete sections have been published. To present the number and order of the beds, and to prepare the way for a clear understanding of the formations and their condition, the following section, selected from the materials gathered for my Report upon the Geology of Tennessee, is given. It was made in the northern part of Wayne county. The successive beds crop out along a line, which commencing at the level of the Tennessee river (low water) at Clifton, and running back nearly four miles, terminates at the top, and on the end of one of the spurs, or fingers, that jut out from the high flat lands further east. The beds are arranged in descending order. The term Niagara is made to include both the Clinton and Niagara groups of New York.

CARBONIFEROUS.	9. Top of ridge overlooking the valley of Eagle Creek. Strata concealed; loose cherty masses scattered over the surface containing occasional fossils, 53 feet.
DEVONIAN, *Hamilton group?*	8. Strata (when weathered) *bluish or greenish siliceous shale.* Eight feet at the base interstratified with thin, smooth, fine-grained sandstones which are charged with individuals of a small *Lingula*, 42 feet.
	7. *Fine-grained sandstone* highly charged with the same *Lingula* as above, 8 feet.
UPPER SILURIAN. *Lower Helderberg?*	6. *Grey crinoidal Limestone*—Fossils obscure at this point,—the horizon, however, of well marked Lower Helderberg rocks at other points in Wayne county, 25 feet.
UPPER SILURIAN. *Niagara, the Sponge-Bearing Bed.*	5. *Glade-forming Limestones and Calcareous Shales.*—The limestone grey often coarse crinoidal—sometimes argillaceous—All very fossiliferous—occasionally containing layers of chert, 90 feet.
UPPER SILURIAN. *Niagara, the Variegated Bed.*	4. *Variegated Limestone;* brownish-red and grey layers interstratified—many layers argillaceous—*orthocerata* abundant in lower part, 96 feet.
LOWER SILURIAN. *Hudson River.*	3. *Greenish calcareous Shale,* containing *Leptæna sericea,* and *Strophomena alternata,* 15 feet.
	2. *Blue Limestone* in rough thick-bedded layers containing *Strophomena alternata, S. tenuistriata, Rhynconella increbescens, R. dentata,* Cyclonema bilix, Columnaria stellata, &c., 21 feet.
	1. *Blue fine-grained Limestone*—in thin smooth layers separated by shaly leaves—has been used as "Hydraulic Limestone"—contains *Orthis testudinaria, Rhynconella modesta, Lingulæ, Trilobites,* &c., 70 feet.

The beds numbered 4, 5, and 6, represent all the glade-forming limestones and shales, and it is to these that attention is especially invited. In this part of Wayne county, their entire thickness is seen to be 211 feet.

No. 4. *Variegated Limestone.*—This bed, the first I notice, rests directly upon the Hudson river rocks. The junction is well seen at Clifton and below that place, for several miles, along the eastern bank of the Tennessee river. This bed is seen in the glade region occupying generally a low position. Outside of Wayne and Hardin counties its base is rarely seen. The vicinity of Clifton is the most favorable place for studying the entire bed, that has come under my observation.

It is easily recognized by interstratified brownish-red layers, some of which, when crinoidal, furnish a pretty good marble. It is, however, often argillaceous and crumbling.

Its red color, due to sesquioxyd of iron, may indicate its Clinton affinities.

This bed is, in general, comparatively barren in fossils. Occasionally its layers are crinoidal. *Atrypa reticularis*, and several species of *orthocerata* are met with. At Clifton, the base of the bed, the entire mass, is exceedingly rich in individuals of several species of *orthoceras* and in large crinoidal stems and roots. The sponges especially are abundant.

No. 5. *Gray Limestones and Shales*, or the *Sponge-bearing Bed.*—This is the division to which Dr. Roemer's fauna belongs. It is a series of gray crinoidal limestones and calcareous shales, the latter often predominating. On the sloping marly glades the layers of limestone frequently crop out in two or three successive ledges separated by masses of shale. Thin layers of chert often occur interstratified with the limestone. Fossils abound, among them *Astraeospongia meniscus* is very characteristic, in fact the mass might well be called the *Meniscus bed.*

The general thickness of the bed is from 80 to 100 feet. In this respect, however, it is quite variable; at a few points the thickness is reduced to 30 and even to 20 feet. In the section above it is given at 90 feet; it is quite possible, however, that a portion of the overlying bed (as in it, at this point, no characteristic fossils were observed) ought to be included, thus making the thickness to a small extent greater.

The *Sponge-bearing Bed* is the prevalent rock of the glades in Hardin, Wayne, Decatur and Perry counties. It also occurs, to some extent, in Humphreys, Benton and Henry.

Nearly all of the species given by Dr. Roemer in his monograph are found in this bed. There are a few, however, which, so far as my observations extend, are confined to the bed next above, having been seen, *in place*, only in these rocks; the most important, perhaps, is *Pentamerus galeatus. Spirifer macropleura*, (*S. Niagarensis*, var. *oligoptycha* of the monograph) although in New York a Lower Helderberg form, is properly included in this fauna as it occurs in this as well as in the overlying bed. *Calceola Tennesseensis*, Roemer, is the same as *C. Americana*,

Safford, described in a previous number of this Journal, (vol. xxix, p. 248). The latter name must give place to the former. On a future occasion I shall have remarks to make upon other species given in Dr. Roemer's monograph.

No. 6. *Lower Helderberg.*—We come now to a bed of strata presenting a fauna quite different from that illustrated by Dr. Roemer. It occurs well marked at numerous points within the glade region and in the counties mentioned. The place of this bed is immediately below the Devonian shales and sandstones cropping out, when present, from beneath those on the hill-sides. At many points it is the surface rock. Many of the glades, with naked summits, present only Niagara rocks. Some, however, are capped by this formation. This division, as a bed, and looking over the whole region, is to a considerable extent cut up and fragmentary.

In thickness it varies much; at some points it is entirely absent, No. 7 or 8 resting immediately upon the Sponge-bearing bed; then again it swells out to 60 or 70 feet, and perhaps to as much as 100 feet although I have not any where, as yet, measured so great a thickness.

So far as it regards the particular section presented, it is not certain that No. 6 is wholly, or even in part, Lower Helderberg, no characteristic fossils having been seen. It marks, however, the horizon of these rocks. Within a few miles of this point, the bed holding this position is well characterized in good sections.*

To my mind it is evident, that this bed was subjected to very considerable denudation before the deposition of the Devonian shales and sandstone; hence its variable thickness, or its absence when, in complete sections, the latter rocks are present. Going further back, I have reason to think that the floor of Niagara rocks, upon which this bed rests, was also previously subjected, (but not in so great a degree,) to denudation, and hence the varying thickness of the Niagara bed. This, too, will explain what appears to be the fact, that where the Niagara bed is thin the other becomes thicker, the two in this respect being, to a certain extent, complementary to one another. The Helderberg sediments filled up the hollows and basins of the partially denuded Niagara floor.

Lithologically the bed under consideration cannot easily be distinguished from the one below it. But its fossils, as a whole,

* I take this opportunity of expressing my thanks to my friend and former pupil, A. B. Gant, Jr., of Cravens Mills, Wayne county, for valuable assistance rendered me in my investigations on Indian and Eagle creeks. Mr. Gant has discovered several most interesting localities of fossils in both Wayne and Hardin counties. His ability and zeal promise much more with reference to the interesting geological features of this region.

are quite different. Here the characteristic sponges of the Niagara bed disappear; and so do the crinoidal forms so well illustrated by Dr. Roemer.

In their places we have other species, mostly brachiopods, the larger portion of which are known to occur in the Lower Helderberg rocks of New York. Below is a list of some of the described species. These have all been collected by the writer from the bed in question. Most of them may be found in all, or nearly all the counties bordering the Tennessee river. With the exception of the last, they have all been compared directly with New York specimens.

Eatonia (Atrypa) singularis.	Rhynchonella mutabilis, Hall.
Merista (") laevis.	Orthis subcarinata, Hall.
" (") bella, Hall.	" oblata, Hall.
Rhynchospira formosa, Hall.	" varica, Hall.
" globosa, Hall.	Spirifer perlamellosa, Hall.
Nucleospira ventricosa, Hall.	Strophomena punctulifera, Conrad.
" concentrica, Hall.	Phacops Hudsonicus, Hall.
Pentamerus Verneuili, Hall.	Anisophyllum Agassizi, Edwards and Haime.
" galeatus, Hall.	

Dr. Roemer's beautiful species, *Rhynchonella Tennesseensis*, as well as *Athyris tumida*, as he has it, ought perhaps to be included in the Lower Helderberg fauna; I have seen many perfect individuals of the first in these rocks, and but a few uncertain fragments in the debris of the Niagara, or Sponge-bed; of the second species, but few individuals have come under my observation and I am more in doubt as to its true position.

The following among the brachiopods given in the monograph are common to the two beds; Atrypa reticularis, Rhynconella Wilsoni, Orthis elegantula, Spirifer ("Niagarensis") macropleura and Strophomena depressa.

Within a few months I hope to be able to present a more detailed and systematic account of these rocks, together with complete lists of the fossils they contain.

Lebanon, Tenn., January, 1861.

ART. XIX.—*Correspondence of* JOACHIM BARRANDE, SIR WILLIAM LOGAN *and* JAMES HALL, *on the Taconic System and the age of the Fossils found in the Rock of Northern New England, and the Quebec Group of Rocks.*

I. INTRODUCTORY REMARKS.

As some of our foreign readers may not be acquainted with the question to which the following important correspondence relates, we think it advisable to make a few explanatory observations by way of introduction. A complete history of the whole subject would require a greater amount of space than can be afforded and we shall therefore touch only upon a few of the more salient points.

The rocks under discussion occupy a belt of country east and west from twenty to sixty miles wide, stretching from the vicinity of the city of New York in a northerly direction to Lake Champlain and thence through Vermont and Lower Canada to Cape Gaspé at the mouth of the St. Lawrence. The strata consisting of slates, limestones, sandstones and conglomerates are greatly disturbed, plicated and dislocated, and are often, especially along the eastern side of the belt, in a highly metamorphic condition. On this side they are overlaid unconformably by upper Silurian and Devonian rocks, but on the western and northern margin they are in contact with and in general seem to be a continuation of the Lower Silurian. Some of the slates of the formation closely resemble in lithological characters those of the Hudson River group and thus along the western side of the region, where the junction of the two formations occurs, it is often almost impossible to draw the line between them. The dip and strike of both are in the same direction and throughout extensive areas the newer rocks appear to plunge beneath the older. The whole district affords an excellent example of those cases, so well known to field geologists, where the true relations of the different masses cannot be clearly worked out without the aid of fossils and where the best of observers may arrive at diametrically opposite opinions.

Dr. Emmons, one of the geologists of the New York Survey, early convinced himself by a careful examination of these rocks, that they constituted a distinct physical group more ancient than the Potsdam sandstone, the latter being regarded by him as the base of the Lower Silurian System in North America. His views were given in detail in 1842 in his final report on that part of the State confided to his charge, and in a more special manner in another work entitled "THE TACONIC SYSTEM," published in 1844. In this latter work he figured several species of fossils which had been collected in different parts of the formation. Two of these were trilobites and were described under

the names of *Atops trilineatus* and *Elliptocephala asaphoides*. The others were graptolites, fucoides and apparently trails of annelides; he considered all the species to be distinct from any that had been found in American rocks of undoubted Silurian age. The pre-silurian age of the formation has also been maintained by him in several more recent publications such as his "American Geology"—the several reports on the geological survey of North Carolina and in his "Manual of Geology."

On the other hand, Professor Hall placed the whole region in the Hudson River group. In the first volume of the Palæontology of New York he identifies *Atops trilineatus* with *Triarthrus Beckii* the characteristic trilobite of the Utica slate;—*Elliptocephala asaphoides* he refers to the genus *Olenus* and describes as congeneric therewith another trilobite (*O. undulostriatus*) said to be from the true Hudson River shales. It is scarcely necessary to state that these identifications have always afforded an extremely powerful objection against the correctness of the position assumed by Emmons, because no species of trilobite is known to range from the Primordial Zone up to the top of the Lower Silurian. Hall's first volume was published in 1847 and as it is unquestionably the most important work on the Lower Silurian Fossils of North America it has been very generally accepted by our physical geologists as a guide. It is not surprising therefore that, in all the discussions that have taken place during the last fourteen years upon the age of these rocks, the majority of those who did not profess to be naturalists should have arranged themselves on the side of the leading Palæontologist of the country.

The formation was traced from New York through Vermont and there identified, by Prof. Adams the State Geologist, with the Hudson River group. The Canadian Surveyors continued it with great labor through a mountainous and partially uninhabited country for nearly five hundred miles further, from the northern extremity of Vermont to the neighborhood of Quebec and thence along the south side of the St. Lawrence to the mouth of that river at Cape Gaspé. In Canada the nomenclature of the New York Survey was adopted for all the formations and it appears from his several reports that Sir W. E. Logan could find nothing in the physical structure of the country to authorize him to make an exception in favor of this particular series of rocks. It has therefore always been called the Hudson River group in the publications of the Canadian Survey.

It will be seen by the following correspondence that the new light thrown upon the question of the age of these rocks by the fortunate discovery of a large number of fossils near Quebec, now leads him to place them at the base of the Lower Silurian, and as he states that the shales in Vermont in which the trilobites no-

ticed in Mr. Barrande's letter to Prof. Bronn have been found may be subordinate to the Potsdam it seems probable that the sequence contended for by Emmons will turn out to be at least for the greater part the true one.

II.

ON THE PRIMORDIAL FAUNA AND THE TACONIC SYSTEM OF EMMONS, IN A LETTER TO PROF. BRONN OF HEIDELBERG.*

"Paris, July 16, 1860.

"..... I have recently received, thanks to the kindness of Mr. E. Billings, the learned palæontologist of the Geological Survey of Canada, a very interesting pamphlet entitled 'Twelfth Annual Report of the Regents of the University of the State of New York, 1859.' If you possess this publication, you will find there, at page 59, a memoir of Prof. J. Hall, entitled 'Trilobites of the Shales of the Hudson River Group.' This savant there describes three species under the names *Olenus Thompsoni*, *Olenus Vermontana*, and *Peltura* (*Olenus*) *holopyga*. The well-defined characters of these trilobites are described with the clearness and precision to be expected from so skillful and experienced a palæontologist as James Hall.

"Although the specimens are incomplete, their primordial nature cannot admit of the least doubt, when the descriptions are read, accompanied with wood engravings which the large dimensions of these three species render sufficiently exact. The first is 105 millim. long by 80 broad, the other two are somewhat smaller.

"The heads of the two *Oleni* being deteriorated, the furrows of the glabella cannot be recognized. The thorax has a common and remarkable character, which consists in the greater development of the third segment, the point of which is stronger and longer than in all the other pleura. This is a striking resemblance to the *Paradoxides*, the second segment of which has the same peculiarity. Besides, there is an intimate relation between these two primordial types, and we should not be surprised if America furnished us with forms uniting most of their characteristics. The pygidium of *O. Thompsoni*, the only one that is known, shows no segmentation, and attests by its exiguity its relation to a primordial trilobite. *P. holopyga*, by its whole appearance, resembles the species of Sweden so well known by the name of *P. Scarabæoides*.

"Thus all the characters of these three trilobites, as they are recognized and described by J. Hall, are those of the trilobites of the primordial fauna of Europe. This is so true, that I think I may say without fear, if M. Angelin, or any other palæontologist practised in distinguishing the trilobites of Scandinavia, had met with these three American forms in Sweden or Norway, he would not have hesitated to class them among the species of the Primordial fauna, and to place the schists enclosing them in one of the formations containing this fauna. Such is my profound conviction, and I think any one who has made a serious study of the trilobitic forms and of their vertical distribution in the oldest formations will be of the same opinion.

* Proceed. Boston S. N. Hist., vol. vii, Dec., 1860, p. 371.

"Besides, all who have seriously studied palæontology know well that each geological epoch, or each fauna, has its proper and characteristic forms, which once extinct reappear no more. This is one of the great and beautiful results of your immense researches, which have generalized this law, recognized by each one of us within the limits of the strata he describes.

"The great American palæontologist arrived long since at the same conclusion, for in 1847 he wrote the following passage in the *Introduction* to the first volume of the Monumental Work consecrated to the Palæontology of New York.

"'Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms. We are more and more able, as we advance, to observe that the Author of nature, though always working upon the same plan and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence have performed their parts in the economy of creation, have lived their period and perished. This we find to be as true among the simple and less conspicuous forms of the palæozoic series, as in the more remarkable fauna of later periods.'—*J. Hall*, '*Pal. of New York*,' i, p. XXIII."

"When an eminent man expresses such ideas so eloquently, it is because they rise from his deepest convictions. It must then be conceived that J. Hall, restrained by the artificial combinations of stratigraphy previously adopted by him, has done violence to his palæontological doctrines, when, seeing before him the most characteristic forms of the *Primordial fauna*, and giving them names the most significant of this first creation, he thinks it his duty to teach us that these three trilobites belong to a horizon *superior* to that on which the second fauna is extinguished.

"In effect, according to the text of J. Hall, the three trilobites in question were found near the town of Georgia, Vermont, in schists which are superior to the *true Hudson River group*. In his works J. Hall does not go beyond indicating the horizon of certain fossils, and no one would think of asking a guaranty for such indications. But on this occasion the great American palæontologist thinks it necessary to support his stratigraphical determination by another authority, chosen from the most respectable names in geology. The following is the note which terminates his Memoir.

"'NOTE.—In addition to the evidence heretofore possessed regarding the position of the shales containing the Trilobites, I have the testimony of Sir W. E. Logan, that the shales of this locality are in the upper part of the Hudson River group, or forming a part of a series of strata which he is inclined to rank as a distinct group, above the Hudson River proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent.'

"Now, when a savant like J. Hall thinks himself obliged to invoke testimony to guarantee the exactness of the position of a few fossils, it is clear that the determination of this position is difficult.

"In order to understand these difficulties I have consulted the maps and documents relating to the State of Vermont and the country in which the town of Georgia is situated, and, although the library of our Geological Society does not contain all that one could wish on this subject, I recognized easily that Georgia is placed in the region where the order of succession of the deposits is the most obscured by foldings and dislocations; so that the position of the schists in question could not have been determined by the incontestable evidence of direct superposition. Besides, the physical appearance of these schists is not that of the rocks constituting the typical group of Hudson River. This is verified by the Note of J. Hall, for it tells us that Sir W. E. Logan is inclined to make a distinct group of these schists *superior* to that of the Hudson, and which consequently *would crown the whole Lower Silurian division* of the continent.

"For the above reasons, the geological horizon on which the three *Oleni* of Georgia were found appears to me, at first view, to have been but doubtfully determined, and in complete opposition to palæontological documents.

"I do not think, then, that I weaken in the least degree the respect and confidence justly inspired by the labors of the American savants whose names have just been mentioned, when I ask them in the name of science to make new researches and new studies, that may lead to a final and certain solution of this important question.

"Doubtless, thanks to the progress of our knowledge, we are now no longer bound by the ancient conception of the simultaneous extinction and the total renovation of the faunæ. As for myself, in particular, it would not be possible to accuse me of similar views at the moment when I am publishing the explanation of my doctrine of colonies. But you will perceive that the facts which I invoke in support of this doctrine are far from sustaining the reappearance of a fauna after the extinction of the following fauna, which the three trilobites of Georgia would do, if they had really lived after the deposit of the Hudson River group.

"This reappearance would be still more astonishing, as among the three great Silurian faunæ the second fauna occupies the greatest vertical space and is probably the one which enjoyed the longest existence. Thus, to verify such a reappearance, the most incontestable proofs are required, for such a decision would compel the entire re-formation of one of our most important scientific creeds. "Yours very truly,

J. BARRANDE."

In another letter, dated Paris, 14th August, 1860, Mr. Barrande says:—

"You will easily perceive the interest and importance of the question, even if it were only raised on account of the three *Oleni* of Georgia; but it takes in now a much wider field, owing to a letter I have just received from Mr. Billings, official Palæontologist of the Geological Survey of Canada, who informs me that he has found lately, in the schists and limestones near Quebec, considered as being the prolongation of those in question in Vermont, nearly one hundred species, almost all new. Twenty-six of these come from a white limestone, and seem to him to be the true representatives of the Primordial fauna, and he cites among them *Conocephalites*,

Arionellus, *Dikellocephalus*, etc., that is, very characteristic forms of this fauna.

"In another limestone, which is gray, he finds thirty-nine species, all different from the first, and representing, on the contrary, the most distinct types of the second fauna. Finally, the black schists furnish him with *Graptolites*, *Lingulæ*, etc., etc., fossils which at first sight cannot determine a horizon, because they are found upon several Silurian horizons.

"While waiting for these very obscure stratigraphical relations to be disentangled, and without committing in any manner Mr. Billings, who should preserve the independence of his opinion, I may yet express to you my view wholly personal, and of which at this moment I take the entire responsibility. I think, then, that this region of schists and limestones of Vermont, in other words the *Taconic system*, will reproduce in America what took place in England as to the Malvern Hills, and in Spain for the Cantabrian chain,—that is to say, the Primordial fauna, after having been disregarded, will regain its rights and its place, usurped for a time by the second fauna.

"You see it is a great and noble question, whose final solution will complete the imposing harmonies existing already between the series of palæozoic faunæ of America and that of the contemporaneous faunæ of Europe, leaving to each the imprint peculiar to its continent.

"I can well imagine, from the position previously taken by our learned American brethren on the subject of the Taconic system, that the final solution of which I speak will not be obtained without debate, and perhaps some wounding of self-love, for some opinions that appear to be dominant must be abandoned.

"But experience has taught me that in such cases the most elevated minds turn always first to the light, and put themselves at the head of the movement of reform. Thus, when in 1850 I recognized the Primordial fauna in the Malvern Hills, where the second fauna only had been found, Sir Henry de la Beche and Sir Roderick Murchison were the first to adopt my views, to which little by little the other official geologists agreed; Edward Forbes ranged himself publicly on my side in 1853 in 'The Geological Survey,' while others still hesitated, until now there is no longer any opponent.

"I think there will be the same experience in America, and that in a few years from this time the opinions of your savans will have undergone a great change as regards this question.

"It is a fine opportunity for Dr. Emmons to reproduce his former observations and ideas with more success than in 1844.

"Yours very truly,

J. BARRANDE."

III.

REMARKS ON THE FAUNA OF THE QUEBEC GROUP OF ROCKS AND THE PRIMORDIAL ZONE OF CANADA.* (IN A LETTER ADDRESSED TO MR. JOACHIM BARRANDE OF PARIS, BY SIR WILLIAM E. LOGAN, DIRECTOR OF THE GEOL. SURVEY OF CANADA.)

Montreal, 31st Dec., 1881.

My Dear Mr. BARRANDE:

I am much indebted to you for your letter of the 6th of August, which was accompanied by a copy of your communication to Professor Bronn of Heidelberg, dated 16th July. Agreeably to your request, I took an early opportunity of letting Mr. Hall have a copy of your communication to Prof. Bronn, and he received it on the 11th or 12th September, 1860.

I am of course aware, from the correspondence you have had with my friend Mr. Billings and myself, how far you are acquainted with our discoveries at Quebec. On two occasions, just previous to the receipt of your last letter to Mr. Billings (received the 8th November), I devoted the short time I could spare from other engagements connected with the Geological Survey, to farther researches at Point Levi. I have satisfied myself, notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata. Without entering at present on minute details of structure, I may say that the chief part of the specimens, found up to this time, are from two parallel out-crops, which might be taken as representing two distinct layers. If they are such, they are comprehended in a thickness of about 150 feet; but the circumstances of the case, connected with the physical structure, make it probable that the one band is a repetition of the other through the influence of an anticlinal fold or a dislocation. Both out-crops dip to the southeastward.

From the more northern out-crop (which we shall call A^2) we have obtained *Orthis* 1, *Leptæna* 1, *Camerella* 1, *Lingula* 2, *Discina* 1, *Agnostus* 3, *Conocephalites* 1, *Arionellus* 4, *Dikellocephalus* 6, *Bathyurus* 4. From the more southern out-crop (which we shall call A^3) we have *Dictyonema* 1, *Orthis* 2, *Leptæna* 1, *Strophomena* 1, *Camerella* 1, *Cyrtodonta* (?) 1, *Murchisonia* 3, *Pleurotomaria* 7, *Helicotoma* 2, *Straparollus* 2, *Capulus* 2, *Agnostus* 1, *Bathyurus* 4, *Cheirurus* 2, *Amphion* 2. From a third out-crop, which is still farther southward, and supposed to be another repetition of the same band (which we shall call A^4), we have *Orthis* 1, *Camerella* 1, *Asaphus* (*A Illænoides*) 1, *Bathyurus* 1. Tracing A^2 or A^3 round the extremity of a synclinal, and finding occasional indications of the fossils of A^2 and A^3, we arrive at a position on the south side of the synclinal. We shall call the position P. Here the band A^2 or A^3 ends, but a bed of

* Communicated to this Journal by Sir William Logan.

sandstone a little above it is traceable over an anticlinal to a junction with a conglomerate band lower than A^2 or A^3, showing that A^2 or A^3 must merge into it. Call this A^1. In this we have *Asaphus* (*A. Illænoides*) 1, *Menocephalus* (*M. globosus*) 1. These two species occur in the same fragment of rock. Of all these fossils, 1 *Orthis* is common to A^2, A^3 and A^4; 1 *Leptæna*, 1 *Camerella*, 1 *Lingula*, 1 *Agnostus*, and 1 *Bathyurus*, are common to A^2 and A^3; 1 *Asaphus* is common to A^3 and A^1.

The dip at P is to the southeastward, and therefore an inverted dip. Northwest of this, and therefore above it, at such a distance as would give a thickness of between 200 or 300 feet, we have a band of shale with nodules of limestone, the nodules made up of other rounded masses in a matrix holding fossils, many of them silicified. From a few of these compound nodules we have obtained *Orthis* 11, *Leptæna* 1; this band we shall call B^1. A band like this occurs about half a mile or more to the southwestward. It may be a higher band, or it may be the same band, but we shall call it B^2. From this we obtain *Crinoidæa* (columns) 3, *Orthis* 1, *Camerella* 1, *Nautilus* 1, *Orthoceras* 1, *Leperditia* 1, *Trilobites* (2 genera undetermined) 2. In another position to the southeast, on the southeast of the same anticlinal previously mentioned, we meet with a conglomerate band supposed to be the same as B^2; but, in case it should be different, we shall call it B^3. Here we have *Orthis* 3, *Pleurotomaria* 2, *Murchisonia* 1, *Ophileta* 1, *Helicotoma* 1, *Nautilus* 1, *Maclurea* 1, *Orthoceras* 3 or 4, *Cyrtoceras* 1, *Bathyurus* 1, *Illænus* 2, *Asaphus* 1. Of all these fossils, 1 *Orthis* and 1 *Camerella* are common to B^1 and B^2; the same *Orthis* and *Camerella* with 1 *Leptæna* are common to B^1, A^4, A^3 and A^2.

To the north of all these exposures, and on the northwest side of a synclinal running parallel with the synclinal already mentioned, fossils have been obtained in a cliff of about 100 feet, composed of limestone conglomerate, thin bedded limestones and shales. Their equivalence is not yet quite certain, but the strata are supposed to be not far removed from A^1 and A^2. We shall call this cliff A. The fossils from it are *Tetradium* 1, *Orthis* 1, *Lingula* 2, *Trilobites* (genus undescribed) 1, with a great collection of compound *Graptolidæ*, described and being described by Mr. Hall under the genera *Graptolithus* 25, *Retiolites* 1, *Reteograptus* 2, *Phyllograptus* 5, *Dendrograptus* 3, *Thamnograptus* 3, *Dictyonema* 3.

I have given you these details of localities, because as the subject requires further investigation we do not yet wish to commit ourselves entirely as to the equivalency of separate exposures. But there is no doubt that the whole is one group of strata deposited under one set of alternating circumstances. The whole fauna, as known up to the present time, is composed of—

Articulata,	36	species.
Mollusca,	55	"
Graptolidæ,	42	"
Radiata,	4	"
	137	

Of this fauna not one species is found in the Anticosti group, where we have a gradual passage from the fauna of the Hudson River formation to that of the Clinton, and not one of any formation higher than the Chazy. Mr. Billings recognizes one species, *Maclurea Atlantica* (Billings) as belonging to the Chazy, and six species as belonging to the Calciferous. They are *Lingula Mantelli* (Billings), *Camerella* undescribed, *Ecculiomphalus* undescribed, *Helicotoma uniangulata* (Hall), *H. perstriata* (Billings), and one remarkable species of an undetermined genus, like a very convex *Cyrtodonta*, which occurs both at Mingan and point Levi. All of the forms, particularly the trilobites, remind the observer of those figured by Dr. D. Dale Owen from the oldest fossiliferous rocks of the Mississippi valley, while independent of the six species identical with Chazy and Calciferous forms, there are many others closely allied to those found in the latter formation in Canada.

From the physical structure alone no person would suspect the break that must exist in the neighborhood of Quebec, and without the evidence of the fossils, every one would be authorized to deny it. If there had been only one or two species of an ancient type, your own doctrine of colonies might have explained the matter, but this I presume would scarcely be applicable to so many identities in a fauna of such an aspect. Since there must be a break, it will not be very difficult to point out its course and its character. The whole Quebec group, from the base of the magnesian conglomerates and their accompanying magnesian shales to the summit of the Sillery sandstones, must have a thickness of perhaps some 5000 or 7000 feet. It appears to be a great development of strata about the horizon of the Chazy and Calciferous, and it is brought to the surface by an overturn anticlinal fold with a crack and a great dislocation running along the summit, by which the Quebec group is bronght to overlap the Hudson River formation. Sometimes it may overlie the overturned Utica formation, and in Vermont points of the overturned Trenton appear occasionally to emerge from beneath the overlap.

A series of such dislocations traverses eastern North America from Alabama to Canada. They have been described by Messrs. Rogers, and by Mr. Safford. The one in question comes upon the boundary of the Province not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress; thence it

coasts the north side of the Island of Orleans, leaving a narrow margin on the island for the Hudson River or Utica formation. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here again it leaves a strip of the Hudson River or Utica formation on the coast.

To the southeast of this line the Quebec group is arranged in long narrow parallel synclinal forms with many overturn dips. These synclinal forms are separated from one another on the main anticlinals by dark grey and even black shales and limestones. These have heretofore been taken by me for shales and limestones of the Hudson River formation, which they strongly resemble, but as they separate the synclinals of the Quebec group must now be considered older. I am not prepared to say that the Potsdam deposit in its typical form of a sandstone is anywhere largely developed above these shales, where the shales are in greatest force. Neither am I prepared to assert its absence, as there are in some places masses of granular quartzite, not far removed from the magnesian rocks of the Quebec group, which require farther investigation; but, from finding wind-mark and ripple-mark on closely succeeding layers of the Potsdam sandstone where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was even exposed at the ebb of tide. Out in deep water the deposit may have been a black partially calcareous mud, such as would give the shales and limestones which come from beneath the Quebec group.

In Canada no fossils have yet been found in these shales, but the shales resemble those in which *Oleni* have been found in Georgia (Vermont). These shales appear to be interposed between eastward dipping rocks equivalent to the magnesian strata of the Quebec group, and they may be brought up by an overlapping anticlinal or dislocation. We are thus led to believe that these shales and limestones, which may be subordinate to the Potsdam formation, will represent the true primordial zone in Canada.

Mr. Murray has this season ascertained that the lowest rock that is well characterized by its fossils in the neighborhood of Sault Ste. Marie, near Lake Superior, really belongs to the Birdseye and Black River group, and that it rests on the sandstones of Ste. Marie and Lacloche, the fossiliferous beds at the latter place being tinged with the red color of the sandstone immediately below them. These underlying Lake Superior rocks may thus be Chazy, Calciferous, and Potsdam, and may be equivalent to the Quebec group and the black colored shales beneath. The Lake Superior group is the upper copper-bearing

series of that region, and rests unconformably upon the lower copper-bearing series, which is the Huronian system. The upper copper-bearing series holds nearly all the metals, including gold, and so does the Quebec group, each making an important metalliferous region. Each when unmetamorphosed holds a vast collection of red colored strata. The want of fossils in the Lake Superior group makes it difficult to draw lines of division, but if any part represents the primordial zone, I should hazard the conjecture that it is the dark colored slates of Kamanistiquia, which underlie all the red rocks.

Professor Emmons has long maintained, on evidence that has been much disputed, that rocks in Vermont, which in June, 1859 I for the first time saw and recognized as equivalent to the magnesian part of the Quebec group, are older than the Birdseye formation; the fossils which have this year been obtained at Quebec pretty clearly demonstrate that in this he is right. It is at the same time satisfactory to find that the view which Mr. Billings expressed to you in his letter of the 12th July, to the effect that the Quebec trilobites appeared to him to be about the base of the second fauna, should so well accord with your opinions; and that what we were last spring disposed to regard at Georgia as a colony in the second fauna, should so soon be proved, by the discoveries at Quebec, to be a constituent part of the primordial zone. I am, my dear Mr. Barrande,

Very truly yours,

W. E. LOGAN.

Mr. Joachim Barrande, Rue Mezière No. 6, Paris.

IV.

LETTER FROM JAMES HALL, PALÆONTOLOGIST OF NEW YORK, TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

Gentlemen,—In the Twelfth Annual Report of the Regents of the University* upon the State Cabinet of Natural History, I published descriptions of three species of Trilobites from the shales of the town of Georgia in Vermont, referring them to the age of the Hudson River group. These trilobites had been in my possession for some two years or more; and knowing the great interest that would attach to them, whenever published, I had waited, hoping that some new facts might be brought out touching the stratigraphical relations of these rocks in the town of Georgia.

After the descriptions had been printed and a few copies distributed, I learned that Sir William Logan was at that time

* The same to which Mr. Barrande refers in his text to Prof. Bronn, p. 312. The preceding communications sufficiently explain the subject under discussion.

actually investigating the rocks of that part of Vermont. Desiring to know the results of his latest researches in regard to the stratigraphical relations of these rocks, I withheld the final publication till the Meeting of the American Association for the Advancement of Science, in Springfield, and there showed to Sir William my descriptions as they now stand in the Report, and I then received his authority for the addition of the note which was appended.

This in a few words is a simple history of the matter relating to the publication of these species. I made no remarks or comparisons with the primordial fauna of Barrande in Bohemia, knowing that these features would be at once recognized by every palæontologist; while their reference to the genus Olenus showed my appreciation of the nature of the fossils.

I received a copy of the communication of Mr. Barrande, from Sir William Logan in September, a few days before setting out for my field duties in Wisconsin. Since my return to Albany, constant and pressing occupation has left me no time to consider a reply to a question of so much importance.

Later discoveries in the limestones associated with the shales at Quebec leave no longer a doubt, if any could have been entertained before, that the shales of Georgia, Vermont, are in the same relative position; and we must regard these three trilobites as belonging to the same fauna with the species enumerated by Sir William Logan as occurring in the Quebec group. Left to palæontological evidence alone, there could never have been a question of the relations of these trilobites, which would at once have been referred to the primordial types of Barrande.

Sir William Logan yields to the palæontological evidence, and says, "*there must be a break.*" He gives up the evidence of structural sequence which he had before investigated and considered conclusive; and having heretofore relied upon the opinion of the distinguished Geologist of Canada in regard to a region of country to which my own examinations had not extended, I have nothing left me but to go back to the position sustained by palæontological evidence. Let us for a moment examine this palæontological evidence.

The identifications of the fossils of the Quebec group, certainly show a remarkable agreement between the trilobites of this group and those of the Potsdam sandstone, in the occurrence of *six species* of *Dikellocephalus* and one of *Menocephalus;* while the occurrence of many others is in agreement or not incompatible with the fauna of the Potsdam and Calciferous sandstones. The comparative values of the Trilobitic faunæ of this group and of the primordial zone of Europe, as established by Barrande, is better shown in a tabular form which I here append.

The Crustacean fauna of the primordial zone of Europe.

Paradoxides, Olenus, Peltura, Conocephalus, Ellipsocephalus,* Hydrocephalus, Sao, Arionellus,	These genera are all limited to the *fauna primordiale*, and none of the other European genera of trilobites are known in this fauna.
Agnostus,	Of the first and second fauna.
Amphion,	Placed with doubt in the first fauna, and is well developed in the second fauna.

The Crustacean fauna of the Quebec Group.

Conocephalus, Arionellus,	Genera of the *primordial zone.*
Agnostus,	A genus passing from the first to the second fauna.
Dikellocephalus, Menocephalus,	Genera of the Potsdam period.
Bathyurus,	Quebec group.
Asaphus,	Of the second fauna.
Illænus,	Of the second and third fauna.
Amphion,	Of the second fauna; and doubtfully of the first fauna in Sweden.
Ceraurus = Chierurus,	Of the second and third Silurian faunæ, and of the Devonian fauna.

We have therefore in the Quebec Group, two established genera of the primordial zone; one, Agnostus, which passes from the primordial to the second fauna; one, Amphion, cited as doubtful in the first fauna in Sweden, and known to be in the second; and three,—Asaphus, Illænus and Chierurus, which begin their existence in the second fauna. Of these, Asaphus begins and ends in the second; Illænus begins with the second and continues to the third; while Ceraurus = Chierurus begins in the second, extends through the third Silurian, and appears in the Devonian fauna.

Bathyurus is a new genus, and as yet has no stratigraphical value in comparisons. Those which I described as Olenus have proved to be not true Oleni; and though much resembling that genus, are nevertheless distinct; and I have proposed the names *Barrandia* and *Bathynotus* for the two forms.† These have yet no stratigraphical value, except so far as their relations to established genera may aid in that direction.

The genera *Dikellocephalus* and *Menocephalus* are of the Potsdam group; and so far the Quebec group is in parallelism with the Potsdam and Calciferous strata.

Of the other genera, we know Asaphus, Illænus and Ceraurus (= Chierurus) in the Trenton limestone and Hudson River groups; Illænus and Ceraurus in the Upper Silurian strata of Niagara age, or the third fauna of Barrande; while Ceraurus

* Not Elliptocephalus of Emmons.

† Thirteenth Annual Report of the Regents of the University of N. Y., on the State Cabinet of Natural History, Albany, December, 1860.

occurs also in the Devonian of Europe. Amphion is known in the second fauna in Europe, and, doubtfully in the first.

Ceraurus does not occur in this country, so far as I know, above the Niagara group; though known in the Devonian rocks of Europe.

The following tabular arrangement of the genera found in the Quebec group will serve to express more distinctly the relations of the Crustacean fauna of these rocks.

The letters at the head of the columns have the same references as those used in the communication of Sir William Logan.

	A	A^1	A^2	A^3	A^4	B^1	B^2	B^3
Arionellus,	....	—	4	....	....	....	....	....
Conocephalus,	....	—	1	....	....	....	....	....
Agnostus,	....	—	3	1	....	....	....	....
Dikellocephalus,	....	—	6	....	....	....	....	....
Menocephalus,	—	1	—	—	—	....	....	....
Bathyurus,	....	—	4	4	1	....	....	1
Barrandia, } *Shales of*	....	....	....	....	....	....	....	....
Bathynotus, } *Georgia, Vt.*	....	....	....	....	....	....	....	....
Amphion,	....	....	....	2	....	....	....	....
Asaphus,	....	1	....	....	1	....	....	1
Illænus,	....	....	....	....	....	....	....	2
Chierurus (Ceraurus),	....	....	....	2	....	....	....	....
Leperditia,	....	....	....	....	....	....	1	....
Lingula,	2	—	2	....	....	....	....	....
Discina,	....	—	1	....	....	....	....	....
Orthis,	1	—	1	2	1	11	1	3
Leptæna,	....	—	1	1	....	1	....	....
Strophodonta,	....	—	....	1	....	....	....	....
Camarella,	....	....	1	1	1	....	1	....
Cyrtodonta ?	....	....	....	1	....	....	....	....
Maclurea,	....	....	....	....	....	....	....	1
Murchisonia,	....	....	....	3	....	....	....	1
Pleurotomaria,	....	....	....	7	....	....	....	2
Helicotoma,	....	....	....	2	....	....	....	1
Straporollus,	....	....	....	2	....	....	....	....
Capulus,	....	....	....	2	....	....	....	....
Ophileta,	....	....	....	....	....	....	....	1
Nautilus,	....	....	....	....	....	....	1	1
Orthoceras,	....	....	....	....	....	....	1	3 or 4
Cyrtoceras,	....	....	....	....	....	....	....	1
Crinoidal columns,	....	....	....	....	....	....	3	....
Tetradium,	1	....	....	....	....	....	....	....
Dictyonema,	3	....	....	1	....	....	....	....
Graptolithus,	25	....	....	....	....	....	....	....
Retiolites,	1	....	....	....	....	....	....	....
Reteograptus,	2	....	....	....	....	....	....	....
Phyllograptus,	5	....	....	....	....	....	....	....
Dendrograptus,	3	....	....	....	....	....	....	....
Thamnograptus,	3 [?]	....	....	....	....	....	....	....

In this table we find, of previously recognized trilobites of the primordial fauna, two genera and five species; of previously known genera of the second and third faunæ, *four genera* and eight species; *two genera* before known in the Potsdam sandstone and seven species; and of Agnostus, which is of the first and second faunæ, two species; and one new genus with nine species.

These are certainly very curious results; and a modification of our views is still required to allow four genera and eight species, (or leaving out Amphion) three genera and six species of the Trilobites of the second fauna to be associated with two genera and five species of Trilobites of the primordial fauna, and yet regard the rocks as of primordial origin.

The Brachiopodous genera, Lingula, Discina, Orthis, Leptæna and Strophomena, have a great vertical range, and are known in the Lower and Upper Silurian, and most of them in the Devonian; while Camerella so far as known is a Lower Silurian form of the second fauna (perhaps also in a lower position).

Of the Gasteropoda, Maclurea and Ophileta are restricted to Lower Silurian rocks, but occur mainly in the second fauna. The other genera occur likewise in the second fauna and in the Upper Silurian rocks as well as some of them in Devonian. The same is true of the Cephalopoda enumerated.

Tetradium is known in the second fauna of the Lower Silurian rocks, and in the upper part of the Hudson River group at the west. Dictyonema is a genus known from Lower Silurian to Devonian strata.

Graptolithus proper extends to the Clinton group of New York; and the same is true of Reteograptus. Thamnograptus occurs in the rocks of the Hudson River group near Albany, and in the Quebec rocks. Phyllograptus and Retiolites are known in the Quebec rocks only; while the typical form of Dendrograptus occurs in the Potsdam sandstone, and, likewise, in three other species, in the Quebec rocks.

We find, therefore, in the other genera except trilobites, very little satisfactory evidence, on which to rely in the present state of our knowledge, for determining the position of these strata.

In the present discussion, it appears to me necessary to go further, and to inquire in what manner we have obtained our present ideas of a primordial, or of any successive faunæ. I hold that in the study of the fossils themselves there were no means of such determination prior to the knowledge of the stratigraphical relations of the rocks in which the remains are inclosed. There can be no scientific or systematic palæontology without a stratigraphical basis. Wisely then, and independently of theories, or of observations and conclusions elsewhere, geologists in this country had gone on with their investigations of structural geology. The grand system of the Professors W. B. and H. D. Rogers had been wrought out not only for Pennsylvania and

Virginia but for the whole Appalachian chain; and the results were shown in numerous carefully worked sections. In 1843, '44 and '45 I had myself several times crossed from the Hudson River to the Green Mountains, and found little of importance to conflict with the views expressed by the professors Rogers in regard to the chain farther south, except in reference to the sandstone of Burlington, and one or two other points, which I then regarded as of minor importance.

Sir William Logan had been working in the investigations of the geology of Canada; and better work in physical geology has never been done in any country.

This then was the condition of American geology, and investigators concurred, with little exception, in the sequence based on physical investigations. As I have before said, our earliest determinations of the successive faunæ depend upon the previous stratigraphical determinations. This I think is acknowledged by Mr. Barrande himself, when he presents to us, as a preliminary work, a section across the centre of Bohemia. With all willingness to accept Mr. Barrande's determination, fortified and sustained as it is by the exhibition of his magnificent work upon the trilobites of these strata, we had not yet the means of parallelizing our own formations with those of Bohemia by the fauna there known. The nearest approach to the type of primordial trilobites was found in those of the Potsdam sandstone of the northwest, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms;* and the prevailing opinion, sanctioned as I have understood by Mr. Barrande, was that the primordial fauna had not been discovered in this country, until the re-discovery of the Paradoxides Harlani, at Braintree, Mass. The fragmentary fossils published in vol. 1, Palæontology of New York, and similar forms of the so-called Taconic System, were justly regarded as insufficient to warrant any conclusions. It then became a question for palæontologists to decide, whether determinations founded on a physical section in a disturbed and difficult region of comparatively small extent, were to be regarded as paramount to determinations founded on examinations, like those of the professors Rogers, extending over a distance in the line of strike of five or six hundred miles; and those of Sir William Logan over nearly as great an extent from Vermont to Gaspé.

It is not possible for me, at this moment, to give the time necessary for a full discussion of this important subject. In presenting these few facts in this form, I am far from doing it in the spirit of cavilling, or as an expression of distrust in any direction. It is plain that the case is not met in Mr. Barrande's plan of successive Trilobitic faunæ; and the facts yet brought out do

* The glabellæ of small trilobites undistinguishable from Conocephalus occur in the Potsdam sandstone near Trempaleau, Wisconsin, on the Mississippi river.

not serve to clear up the difficulty. It is evident that there is an important and perplexing question to be determined,—one that demands all the wisdom and sagacity of the most earnest inquirers, and one which calls for the application of all our knowledge in stratigraphical geology and in palæontology;—one in which coöperation, good will and forbearance are required from every one, to harmonize the conflicting facts as they are now presented. The occurrence of so many types of the second fauna in the rocks at Point Levi, associated with a smaller number of established primordial types, offers us the alternative of regarding these strata as of the second stage, with the reappearance of primordial types in that era, or of bringing into the primordial zone several genera heretofore regarded as beginning their existence in the second stage: in either case, so far as now appears, conflicting with the scheme of Mr. Barrande in reference to the successive faunæ of Trilobites as established in Bohemia and the rest of Europe.

For myself I can say, that no previously expressed opinion, nor any "*artificial combinations of stratigraphy previously adopted*" by me, shall prevent me from meeting the question fairly and frankly. I have not sought a controversy on this point, but it is quite time that we should all agree that there is something of high interest and importance to be determined in regard to the limitation of the successive faunæ of our older palæozoic rocks.

I am very truly yours, &c.,

JAMES HALL.

Albany, N. Y., January 23, 1861.

ART. XX.—*On a new Lead-Salt, corresponding to Cobalt Yellow;* by S. D. HAYES, of Boston.

IN the course of some investigations on the cobalto-cyanid compounds, I was obliged to use a quantity of cobalt yellow, the pigment discovered by M. Saint Evre in 1852.* All the methods described for preparing this salt are very tedious, so that it became an object to find a more ready means. The best method, which has heretofore been given, is to precipitate a solution of nitrate of cobalt, with an excess of potash; then by passing a current of deutoxyd of nitrogen (NO^2) through the mass, the cobalt yellow is obtained; but the greater part of the NO^2 passes through, without being absorbed; the experiment requires hours; and the amount of salt so obtained is very small.

As the composition of this body is considered doubtful, it occurred to me that it might be made from peroxyd of nitrogen (hyponitric acid, NO^4), and after a few trials, I obtained it by this

* Annal. Ch. Phys., 3d series, xxxviii, 177.

agent very readily, in large quantities, and found that all the cobalt contained in a solution may thus be converted into cobalt yellow. Two bottles, connected, and supplied with funnel tubes, are about half filled with a solution of nitrate of cobalt, to which potash, slightly in excess, is added. On passing through the solution a brisk current of NO^4, the mass in the first bottle soon changes color, and the pigment begins to fall; by adding small quantities of potash, occasionally, through the funnel tubes, all the cobalt may be removed. The NO^4 is most readily prepared, by allowing a current of NO^2 made from copper and diluted nitric acid, in a small flask, to mix with a current of common air from a gasometer, in a dry empty bottle, before passing into the cobalt solutions. The current of air can be regulated at the gasometer, and the flask for generating NO^2 can be easily removed, and replenished when necessary. A solution of the carbonate of potash may be used, instead of caustic potash, for precipitating the cobalt solutions, with the same result.

A. Stromeyer, when working upon this salt, endeavored to obtain an analogous body with lead; he succeeded in getting a yellow solution, by means of nitrite of potash, and acetic acid, in a solution of lead, but he then added cobalt, which gave a precipitate.*

On treating a solution of nitrate of lead with potash and passing through it a current of NO^4, precisely as in making the cobalt-yellow, I found that all the NO^4 was absorbed, and as the oxyd of lead disappeared, the solution became very yellow; on evaporating, and crystallizing this, I obtained large, yellow, prismatic crystals; nitrate of potash crystallizes at the same time, and if the NO^4 has been passed through the lead oxyd mixture too long, nitrate of lead is formed.

The yellow salt was easily separated and recrystallized. The bases were determined as sulphates, with the following results:

I. 0·7462 grms. pure salt gave 0·4200 grms. sulphate of lead, and 0·0097 grms. lead =0·3195 grms. oxyd of lead, and 0·2472 grms. sulphate of potash =0·1335 grms. potash.

II. 1·459 grms. gave 0·6387 grms. oxyd of lead, and 0·2593 grms. potash.

III. 1·0271 grms. gave 0·43745 grms. oxyd of lead, and 0·1881 grms. potash.

The nitrogen was determined as gas; metallic copper reduced from the *fine* oxyd, being used in the combustion tube with a little oxyd at the fore end; the gas was collected, and washed in a small apparatus, then transferred to the eudiometer, where it was measured.

I. 0·1926 grms. salt gave 45·6277 cubic centimeters, nitrogen, temperature 60° C.; pressure 277·5 millimetres =16·30 c. c., at 0° C. and 760 mm. pressure =0·2048 grms.

* Ann. Ch. und Pharm., xcvi, 228.

II. 0·1958 grms. gave 16·23 c. c. at 0° C. and 760 mm. pressure =·0226 grms.

The water was determined by combustions with metallic copper.

I. 0·7834 grms. gave 0·0274 grms. water.

II. 0·9145 grms. gave 0·0314 grms. water.

III. 0·4735 grms. gave 0·0177 grms. water.

These results sum up as follows.

	I.	II.	III.	IV.
Oxyd of lead,	42·81	43·08	42·59	43·22
Potash,	17·90	17·77	18·31	"
Nitrogen,	10·63	"	10·35	"
Water,	3·49	3·43	3·73	"
Oxygen, by difference,	25·16	"	25·02	
	100·00		100·00	

The above analyses correspond to the following calculated formula:

PbO,	111·56	42·98
KO,	47·	18·10
N_2,	28·	10·78
O_3,	64·	24·67
HO,	9·	3·47
	259·56	100·00

As this salt crystallizes out with nitrate of potash, it is of about the same degree of solubility, in either hot or cold water, and the solution may be boiled for some time, without any decomposition: but it is readily decomposed by sulphuric, hydrochloric, or nitric acid, giving off red fumes. With the common reagents, it acts as nitrate of lead, but with a solution of sulphate of cobalt, it gives cobalt yellow, which goes down with the sulphate of lead. It loses its atom of water at 100° C., but if the temperature be raised a few degrees higher, the red fumes are given off abundantly. The crystals are of a bright yellow color, and remain unaltered in the air.

I am not yet prepared to give this salt any decided *rational* formula, but its composition may be expressed in several ways, as below. When $2NO_4$ are passed over 2KO, we get $KONO_5$ and $KONO_3$, two distinct salts, but if $2NO_4$ be passed over CoO and KO, as in the case of cobalt yellow, or over PbO and KO as in this salt, we get only one salt of a double composition which we must write—

$$KONO_3\,CoONO_5 \text{ or}$$
$$KONO_3 \text{ or } PbONO_5+HO$$

But there are objections to this: cobalt yellow is almost or quite insoluble in water. These salts may also be looked upon as double per-oxyds, in which two equivalents of oxygen have been replaced by two equivalents of NO_4; but from the nature of the salts, I hardly think that NO_4 exists in them. How-

ever, Gmelin describes a salt to which he gives the formula $2PbO, NO_4\,Aq$,* and we express the composition of these salts quite as well, by writing them thus,

$$KONO_4\ CoONO_4 \text{ or}$$
$$KONO_4, \text{ or } PbONO_4+HO$$

This subject will be pursued, and I hope to get several other salts, which must give some reactions that will lead to the right rational formulæ.

Heidelberg, Baden, Dec. 5th, 1860.

ART. XXI.—*Sketch of the Geology of the Country about the Head-waters of the Missouri and Yellow Stone Rivers;* by Dr. F. V. HAYDEN, Geologist to Capt. Raynolds's Expedition, with an Introductory letter by Capt. W. F. Raynolds, U. S. Topographical Engr.

A. CAPT. RAYNOLDS'S LETTER.

[THE following rapid sketch of the main geological features of the country passed over by the recent expedition to the Head-waters of the Yellow Stone and Missouri rivers, prepared by Dr. F. V. Hayden the Geologist of the Expedition, is submitted for publication by authority of the Honorable Secretary of War.

The district that was examined by the expedition is bounded by the Missouri river on the north and east, by the Platte on the south and by the dividing crest of the Rocky Mountains on the west, and operations were strictly confined to those limits, excepting between the head of Wind river and the Madison fork of the Missouri where the nature of the country was such as to force my division of the party across the main chain of the mountains.

The expedition was in the field for two entire seasons (1859 and 1860) and during about half of the first and the whole of the last season, was divided into two sections or divisions, the first under my immediate control, the second under Lt. Maynadier, U. S. A., the routes travelled over being widely separated so that the amount of labor performed was equal to what would have required three and a half years for a single party; and as operations were all conducted in concert the results must in some respects be more valuable than if obtained by a single party in a longer time.

The total land travel of the different branches of the expedition amounted to nearly five thousand miles independent of having descended in skin and flat boats, the Missouri from Fort Benton to Omaha, N. T., and the Yellow Stone from near the mountains to its mouth.

With the exception of the rivers most of the country had never before been traversed by an exploring party, nor indeed by any whites excepting trappers and not by them for the past fifteen or twenty years.

During the winter months, while the party was stationary on the Platte, Dr. Hayden made a geological examination of the country to the southward along the base of the mountain chain to near Pike's Peak. Dur-

* Handbuch, Bd. 3, s. 142.

ing the active operations of the party he accompanied that part of the command that was with myself—the geological examinations made by the second division were under the immediate direction of Dr. C. M. Hines of this city.

It is believed that the final results of the expedition will add largely to all branches of the scientific knowledge of the country.

W. F. RAYNOLDS, Capt. Top. Engrs. Comdg.]

Washington, D. C., Jan. 17th, 1861.

B. Dr. Hayden's Sketch.

The observations made during the recent expedition to the head waters of the Missouri and Yellow Stone rivers, under the command of Capt. Wm. F. Raynolds, T. E., have served to extend quite largely our knowledge of the geographical area of the different geological formations already indicated as existing in the far West. I propose in the following paper to present a brief abstract of the leading facts ascertained with a view to their bearing upon the physical geology of the mountain chains. I know that it will be impossible within the limits of a single paper to make every point as clear as could be desired or to use terms in all cases in their usually restricted sense. Much of the country passed over, west of the Black Hills, had never before been explored by scientific men, no maps existed which exhibited its topography with any pretensions to accuracy, and the mountain ranges which were known to exist in that region from information given by traders and trappers were not always laid down in their true geographical localities or with their proper trend, and not until the forthcoming report of Capt. Raynolds, now in course of preparation, appears, can these deficiencies be supplied. Moreover, the wild and broken character of the surface of the country examined, uninhabited except by roving tribes of hostile Indians, precluded the possibility of perfect accuracy in all the minor details, and we can only hope that we have obtained a general idea of the principal geological features of the vast area explored. The rocks observed belong to the different geological periods in the following order:

I. Granite, Stratified Azoic, and Eruptive Rocks,*
II. Potsdam Sandstone, (Silurian,)
III. Carboniferous Rocks, (including Permian, ?)
IV. Red Arenaceous Deposits,
V. Jurassic Beds,
VI. Cretaceous with its divisions,
VII. Tertiary Deposits.

* By granite or granitoid, I mean those unstratified crystalline rocks in the West which hold a lower position than any of the stratified deposits and for the most part possess a uniform character, forming the central portions of the larger mountains; by stratified azoic, a series of non-fossiliferous stratified beds, apparently sedimentary between the granite and Potsdam sandstone, and by eruptive rocks, those which have been melted by volcanic heat and brought to the surface in a more or less fluid condition, at various periods.

I. Granite, Stratified Azoic, and Eruptive Rocks.

Under the first division of my subject I will take up the mountain elevations as they appeared in their detached portions along our route. It is now well known that the term "Rocky Mountains" is quite general in its application including a vast number of more or less important ranges of mountains, which when examined in detail seem to have been elevated with very little regularity and in many instances to be but slightly connected, but when viewed in the aggregate to present a trend nearly northwest and southeast. Before reaching the main range we find along the eastern slope many detached minor elevations showing the wide geographical area under which the elevating forces acted.

I allude in the first place to the Black Hills, the northern portion of which we examined on our route from Fort Pierre on the Missouri to the Yellow Stone river. These Hills form the most eastern outlier of the Rocky Mountains and would seem to be an independent elevation were it not for a low anticlinal which extends across the plain country southward connecting it with the Laramie Mountains. The central portion is composed of a coarse flesh colored feldspathic granite with a series of metamorphic slates and schists superimposed, and thence upon each side of the axis of elevation, the various fossiliferous formations of this region follow in their order, to the summits of the Cretaceous, the whole being more or less inclined against the granitic rocks. The distance across the granitoid nucleus, is from fifteen to thirty miles and on each side of the crest or axis of elevation we find the corresponding portions of the fossiliferous beds from the Silurian to the summit of the Cretaceous. The evidence therefore, is conclusive that all the unchanged sedimentary strata at a period of comparatively recent date extended continuously over the whole area occupied by the Black Hills. The eruptive rocks reveal themselves at various localities as at Bear Peak, Inyankara Peak, &c. Bear Peak is a protrusion of very compact igneous rocks, almost isolated from the main range of the Black Hills, and Inyankara Peak is for the part composed of pentagonal basaltic columns arranged in a vertical position. There is no evidence however that they were formed by any force independent of that which elevated the entire range of mountains.

The next range that we examined was the Big Horn which is perhaps the most important detached outlier on the eastern side of the main crest of the continent. This seems to trend nearly northwest and southeast, extending into the valley of the Yellow Stone. The nucleus of these mountains is also composed of red feldspathic granite, with a series of stratified azoic rocks; and the unchanged sedimentary strata to the summit of the Cretaceous and including a portion of the Lignite Tertiary can be

seen in regular sequence outward inclining at greater or less angles. From the observations of Dr. C. M. Hines, who acted as Geologist to the exploring division under Lieut. Maynadier, we know that the corresponding formations occur on the opposite side of the axis of elevation and as we remarked of the Black Hills, we may infer from this fact, that the unchanged sedimentary beds once extended continuously over the whole area occupied by the Big Horn mountains, in a nearly horizontal position sometime during the Tertiary period. As we pass along the northeastern base of the Big Horn mountains southwestward, the ridges of upheaval seem to be presented *en echelon*, the range gradually making a flexure around to the westward. Toward the head waters of Wind River this range as it attaches itself to the main chain of the mountains, changes its lithological characters, no true ancient igneous rocks being seen, but instead, lofty peaks composed of eruptive rocks, presenting every variety of structure from compact basalt to porous lava-like masses.

The Laramie mountains, by which we mean the whole range from the Red Buttes to the Arkansaw, were examined with some care from Red Buttes southward nearly to Pike's Peak. There is a remarkable similarity in the general geological features of all the mountains on the eastern slope. The more lofty elevations as Long's and Pike's Peaks with other ridges and peaks scarcely less lofty than those just mentioned, are composed of the same coarse feldspathic granite before alluded to, but the lower ridges are formed to a great extent of a ferruginous feldspathic granite which easily yields to atmospheric agencies, and the surface of the country is paved with crystals of feldspar in consequence of its decomposition. All along the base and often extending up to the crest of the mountains, we see the outcropping edges of the fossiliferous rocks inclining at greater or less angles, and on crossing over into the Laramie Plains we find the corresponding strata leaning from the opposite side. The granitoid nucleus varies from eight to twenty miles in width. No indications of true eruptive rocks were observed in this range. The Medicine Bow and Sweet Water mountains appear to be of the same character for the most part, but on the east side of the Sweet Water river the evidence of igneous action is shown on a large scale. The ancient volcanic material would seem to have been elevated to a great heighth in but a partially fluid condition and then to have gradually cooled, affecting to a greater or less extent the fossiliferous strata in contact.

Near the junction of the Popo Agie with Wind River, we came in full view of the Wind River mountains which form the dividing crest of the continent, the streams on the one side flowing into the Atlantic, and those on the other into the Pacific. This range is also composed to a large extent of red and gray feldspathic granite with the fossiliferous rocks inclining high

upon its sides. After passing the sources of Wind River, the mountains appear to be composed entirely of eruptive rocks. Even the three Tetons which raise their summits eleven thousand feet above the ocean level are formed of very compact basaltic rock. The Wasatch and Green River ranges, where we observed them have the same igneous origin and the mountains all along the sources of the different branches of the Columbia exhibit these rocks in their full force. In Pierre's Hole, Jackson's Hole and other valleys surrounded by upheaved ridges, these ancient volcanic rocks seems to have been poured out over the country and to have cooled in layers, giving to vast thicknesses of the rocks the appearance of stratified beds.

The mountains about the sources of the Missouri and Yellow Stone rivers are of eruptive origin and in the valley of the Madison fork of the Missouri are vertical walls of these ancient volcanic rocks one thousand to fifteen hundred feet in height, exhibiting the appearance of regularly stratified deposits dipping at a considerable angle. As we pass down the Madison we find some beds of feldspathic rocks and mica and clay slates beneath the eruptive layers, dipping at the same angle. After passing the divide below the three forks of the Missouri we see a number of partially detached ranges which appear to be of the same igneous character. In the Belt, Highwood mountains and indeed all along the eastern slope in this region we find continual evidence of the outpouring of the fluid material in the form of surface beds or in layers thrust between the fossiliferous strata. These igneous beds thin out rapidly as we recede from the point of effusion. A large number of these centres of protrusion may be seen along the slope of the mountains west of the Judith range. The erupted material sometimes presents a vertical wall three hundred feet high, then suddenly thins out and disappears. The Judith, Bear's Paw and Little Rocky Mountains seem to be composed for the most part of granite and other rocks, with igneous protrusions here and there. I have in a former paper expressed the opinion that the central portions of our mountain ranges are composed of feldspathic granite and to a certain extent this is true in regard to the more eastern outliers, but more recent observations have convinced me that these rocks which I have defined by the term eruptive compose by far the greater portion of the mountain masses of the west.

II. Potsdam Sandstone. (*Silurian.*)

The discovery of this formation in its western extension has already been announced in a former paper.* It was first made known as occurring in the Black Hills and resting upon the upturned or nearly vertical edges of the schists, clay slates and granitoid rocks, and the inference was drawn that the same rocks

* This Jour., [2], xxvi, 276.

would be found forming an outcropping belt all along the eastern slope of the Rocky Mountains. After leaving the Black Hills we next observed it along the margins of the Big Horn range near the summit, holding the same relative position and exhibiting the same lithological characters. A few thin layers of fine calcareous sandstone were observed filled with fossils characteristic of this period. At the head of LaBonte creek in the Laramie range I noticed a bed resting discordantly upon azoic slates, fifty to one hundred feet in thickness, holding the same position and possessing the same lithological characters which it reveals at other localities. I could discover no fossils in it at this point but I am confident that this bed represents the Potsdam sandstone. The same bed seems to occur all along the mountains from Laramie Peak to Cache la Poudre creek underlying the well-known Carboniferous strata and resting upon the decomposing granitoid rocks, which form the nucleus of the first ridge. This rock (the Potsdam) is more or less changed by heat from beneath, but I was able to trace it continuously from the source of the Chugwater creek to the source of Cache la Poudre, a distance of over one hundred miles. It was also seen along the eastern slope of the Wind River mountains but did not contain any organic remains.

The above facts show very clearly that in its western extension, the primordial zone of Barrande is represented only by a thin bed of sandstone never exceeding one hundred and fifty feet in thickness, and that is seen only in a very narrow outcropping belt near the margins of the mountain crests. The stratified azoic rocks upon which it rests discordantly so far as my observations have extended, never reach a very great thickness in the west.

III. Carboniferous Rocks, (Including Permian?).

On both sides of the divide of the Rocky Mountains, so far as our explorations have extended, a series of calcareous, areno-calcareous and arenaceous beds are seen which we have referred to the Carboniferous epoch. They vary in thickness at different points. Without specifying localities it will be sufficient to remark that all along the margins of any of the mountain elevations in the far West, these rocks are seen in a more or less inclined position.

Sometimes they are not visible for a short distance (as between the Laramie and Platte Rivers, twenty or thirty miles), but it is plain that they have either been removed by erosion, or concealed by more recent deposits. Along the Big Horn mountains there are alternate layers of sandstone, arenaceous and magnesian limestones, many of which show oblique laminæ and other indications that their deposition took place in shallow and perhaps turbulent waters. They are here developed to a thickness of one thousand

to fifteen hundred feet and incline high upon the sides of the mountains at an angle of 50° to 70°. They contain few fossils but these indicate rocks of the same age as those in the Black Hills. Along the Laramie mountains, from the Red Buttes to Pike's Peak, apparently the same limestones are seen inclining against the sides of the elevated ridges at greater or less angles and on the opposite side of the axis sloping down to the Laramie plains the corresponding strata are seen, though leaning at much smaller angles, usually from 9° to 15°. Along the Sweet Water and Wind River mountains these rocks are highly developed and incline against the sides of the ridges of elevation as heretofore described. The corresponding portions are also seen on the west slope of the main range at the sources of Green and Snake Rivers but not as conspicuously developed, the eruptive rocks predominating. Crossing back over the dividing crest near the sources of the Madison, Jefferson and Gallatin Forks of the Missouri, we find similar limestones largely developed and covering a considerable area on the eastern slope. Near the junction of the three forks and along Smith's or Kamas River we find them reaching a thickness of eight hundred to one thousand feet, often partially changed by contact with igneous rocks beneath. They were also observed around the Judith Mountains and also about the Bear's Paw and Little Rocky Mountains.

Nowhere in the Rocky Mountain range so far as my observations have extended, do the Carboniferous rocks seem to abound in organic remains and the few usually seen are generally found in a bad state of preservation and comprise a limited number of species. The precise period to which these rocks belong, which are so persistent in all disturbed regions, is not positively known, the evidence from organic remains pointing to the age of the Coal measures and sometimes to that of the Lower Carboniferous Period; probably both members of the system occur there.

At the foot of the Big Horn mountains near the head of Powder River, I observed at one locality a series of beds which indicated the presence of Pérmian rocks. These beds which are composed of cherty magnesian limestone are very much like those already described in northeastern Kansas and contain in great abundance some of the same species of fossils as *Myalina perattenuata* and others. I have also seen similar limestones in other localities but no fossils were detected and though having a Permian appearance they may belong to the upper portion of the Carboniferous.

The evidence is clear in many localities that prior to the deposition of the Red Marls succeeding the supposed Permian, a very great erosion of the surface of the Carboniferous rocks took place. We find, for example, in many localities only a thin representation of the Carboniferous rocks and again a full development, one thousand to fifteen hundred feet in thickness.

IV. Red Arenaceous Deposits.

Overlying the Carboniferous rocks and equally persistent with them is a series of red arenaceous Marl beds or gypsum-bearing marls which are coëxtensive with the upheaved sedimentary formations along the Rocky Mountains. The largest development of these beds which I have observed, occurs on the northeastern side of the Big Horn mountains and on the west slope of the Wind River mountains near the source of the Gros Ventres Fork of Snake River. From the Red Buttes on the North Platte to Pike's Peak these beds are often removed by erosion or concealed by superficial deposits, but their appearance in numerous places shows very clearly that beneath the surface they occupy a considerable area throughout the country bordering the mountain ranges, possibly extending entirely over the eastern slope. Passing over into the Laramie Plains we find that the red marls constitute the surface formation of the plain country. It has also been shown from Mr. H. Engelmann's explorations that these beds are revealed along the Wasatch Mountains, even south of Lake Utah, furnishing undoubted evidence that they belong to the same great deposit. The fact also that one thousand to fifteen hundred feet of red arenaceous beds are seen near the sources of Green River, leads to the inference that they continue southward far down the Green River valley to that portion which takes the name of Colorado, and are in fact a continuation of the extensive red deposits, described by various explorers in New Mexico.

These red beds are also seen under similar circumstances highly developed along the mountains at the sources of the Missouri. There seems to be a change in the lithological characters below the Gate of the mountains, the peculiar red deposits disappearing for the most part and a series of irregular layers of siliceous limestone with a reddish tinge, and with oblique laminæ, ripple mark and other indications of shallow water deposition. It is through these layers of rock that the Missouri River cuts its way from the foot of the mountains to the mouth of High Wood creek, about ten miles below the falls. They are also distinctly revealed around the Judith mountains. Along the Big Horn mountains thick layers of gypsum occur, but the gypsum beds are by no means co-extensive with the red deposits, and indeed are present in but few localities. Near the head of Powder River the aggregate thickness of the gypsum strata is about one hundred feet while near the source of Snake River there is a thickness from fifty to eighty feet. It also occurs to a considerable extent at the foot of the mountains, on La Bonte creek, a branch of the North Platte.

V. Jurassic Rocks.

These rocks are everywhere revealed, overlying the red deposits just mentioned and possessing an equal geographical extension. Their fullest development and most fossiliferous condition seems to be along the margins of the Black Hills where they have furnished the most satisfactory evidence of their age. Along the northeastern slope of the Big Horn mountains, this group of rocks presents its usual appearance of grey and whitish calcareous and arenaceous layers, with indurated somewhat variegated beds of more or less laminated marls, containing in great abundance *Belemnites densus, Pentacrinus asteriscus*, a new species of *Ostrea*, *Pecten*, &c.

At Red Buttes we find a fair development of these beds with the same fossils, but as we proceed southward toward Long's Peak, the intercalated laminated marls disappear and the whole formation seems to be reduced to a thickness of fifty to one hundred feet, with very few fossils. Along the southwest side of the Big Horn mountains and the northeast side of the Wind River mountains we have a thickness of Jurassic rocks from eight hundred to one thousand feet containing organic remains in the greatest abundance. Crossing the Wind River mountains we observed the strata corresponding to those upon the eastern side with *B. densus*, *Ostrea*, &c. Returning to the eastern slope at the sources of the Missouri we see occasional indications of their existence, but not so conspicuous as to be readily identified. The age of this group of rocks may be now considered as thorougly established, so great a number of fossils which appear to be of undoubted Jurassic forms have been obtained.

I have remarked that the older fossiliferous beds doubtless pass beneath the more recent Cretaceous and Tertiary deposits and occupy a greater or less area underneath the prairie country east of the 'divide' of the Rocky Mountains. I have made this inference from the fact that where any elevations occur the complete series of fossiliferous beds are exposed around the axis of upheaval. That I may be not misunderstood by those geologists who have colored large areas Triassic and Jurassic on geological maps of the West, I would say, that I have never seen any of the older fossiliferous rocks from the Potsdam to the Jurassic inclusive, exposed except in narrow outcropping belts around the margins of the mountain elevations. The Carboniferous rocks occupy a belt from one to two miles wide, and the red arenaceous deposits are exposed over about the same area, while the Jurassic form a zone never more than one-fourth of a mile to three miles in width.

VI. Cretaceous Rocks with Subdivisions.*

The various subdivisions of the Cretaceous group in the West were observed at numerous localities. The strata in many places occupy large geographical areas, holding a horizontal position, in others forming a belt or zone of greater or less width around the mountain elevations. No. 1 is a well marked and distinct division along the Missouri River from Desoto to a point above the mouth of the Big Sioux River in the eastern portions of Kansas and Nebraska and in the south and southwest. But when we come into the vicinity of the mountain ranges in the northwest its typical form is wanting, and apparently an increased development of No. 2 only is seen. Along the Big Horn mountains, No. 2 is eight hundred to one thousand feet in thickness, composed of black, plastic clay with several layers of gray and yellowish calcareous sandstones ten to fifty feet in thickness. Along the Laramie and Wind River mountains the same characters are shown. After leaving the Missouri near the mouth of the Niobrara river No. 3 is never seen presenting its typical marly character. In the vicinity of the Black Hills we saw a series of beds composed of alternate thin layers of arenaceous and argillaceous sediments with *Ostrea congesta* and *Inoceramus problematicus* which may possibly represent No. 3. Along the Big Horn mountains and from Red Buttes to Cache la Poudre creek the same fossils were often found and some other indications of its existence, but no well marked typical beds were seen. It is now well-known that *O. congesta* and *I. problematicus*, range down into No. 2, so that No. 3 in the west and southwest may give place to an increased development of No. 2. Nos. 4 and 5 are largely developed every where, when not concealed by the overlying Tertiary deposits, especially along the Laramie mountains and in the valley of Cache la Poudre. In the Valley of Wind River all the Cretaceous rocks down to No. 2, appear to have been removed by erosion prior to the deposition of the Tertiary Beds, and the characteristic fossils of No. 2, are quite abundant. As we pass over mountains, we have inclining from the western slope, six to eight hundred feet of alternations of black plastic clays, arenaceous marls and beds of sandstones and limestone with a few seams of Carbonaceous matter passing up into calcareous and arenaceous compact rocks. In some arenaceous limestones near the middle of the series and extending upward, quite abundant fossils were observed, among them a large *Inoceramus*, two species of *Ostrea*, a large *Pinna*, four inches in length, a *Cardium* and a number of undetermined species with fragments of silicified wood. The general dip of these rocks is about 20°. These

* The Cretaceous rocks of the West have been divided into five formations, numbered 1, 2, 3, &c. A more careful study of No. 1? may render it necessary to make other divisions.

well marked Cretaceous beds pass up quite imperceptibly into an enormous thickness of Lignite Tertiary. Passing over the dividing crest to the head waters of the Missouri, we did not observe any indications of Cretaceous rocks until we had descended below the three forks, where we find traces left after erosion. They do not reveal themselves conspicuously until we arrive within twenty or thirty miles of Fort Benton where the black plastic clay begins to overlap the Jurassic rocks with its characteristic fossils, and on reaching Fort Benton the plastic clay is quite homogeneous and is developed to a thickness of eight hundred feet. As we proceed toward the mouth of the Judith River and near the Judith mountains we find quite thick beds of concretionary sandstone which form the "Stone Walls," "Citadel," &c. It is from these beds that we have obtained a group of fossils which we have referred provisionally to No. 1, but which seem to be specifically distinct from all others in the West. It may be that when this group of beds now referred to Nos. 1 and 2, comprising a thickness of fifteen hundred to two thousand feet in this region are more carefully studied that several subdivisions will be made, having equal importance with the others. During the past season our route led us along the 'divide' between the Missouri and Yellow Stone rivers south of the Judith mountains, so that we passed outside of any good exposures of No. 1, as well as beyond the limits of the estuary beds at the mouth of the Judith. We must await a more thorough and detailed exploration of this region before we can state with entire confidence the succession of the beds.

VII. Tertiary Deposits.

In speaking of the Tertiary deposits of the Northwest, so far as known at the present time I propose to separate them into four divisions which will be sufficient for our immediate purposes. 1st, Estuary Deposits. 2nd, True Lignite Beds. 3rd, Wind River Valley Deposits. 4th, White River Tertiary Deposits.

The estuary deposits, of which the Judith basin may be regarded as the type, are quite remarkable and of a most interesting character. Opinions of a somewhat conflicting nature have been entertained in regard to them, owing to the peculiar character of the organic remains, but recent observations have convinced me that they are all of Tertiary age and that they are quite widely distributed throughout the far West. The lithological characters of the Judith deposit have already been sufficiently described and it has yielded many important fossils. A thin series of beds is also found near the sources of the Moreau, Grand and Cannon Ball rivers, and at the mouth of the Big Horn river we have a group of beds eight hundred to one thousand feet in thickness with fossils of the same character as those

occurring at the mouth of the Judith. The researches of Mr. H. Engelmann, in Utah, have also established the existence of an estuary deposit in the country bordering upon Green river,—scarcely less interesting than that of the Judith. These deposits pass up into the true lignite beds without any perceptible line of separation gradually losing their estuary character and ever after containing only land and freshwater shells. The lignite strata are chiefly remarkable for yielding in the greatest abundance, finely preserved vegetable remains. A few fragments of leaves of Dicotyledonous trees and silicified wood, with very impure lignite beds, are formed in some of the estuary deposits but no groups to indicate the great luxuriance of vegetation which must have existed during the accumulation of the lignite strata.

The geographical extension of the lignite deposits of the West is now a matter of the highest interest, and from what is already known, I am convinced that they will yet be found to cover a greater or less area on both sides of the main 'divide' of the Rocky Mountains, from the Arctic Sea to the Isthmus of Darien. The estuary and lignite beds seem also to have partaken equally with the older fossiliferous rocks, of the influence which elevated the mountain chains. Along the Laramie mountains, and from the Red Buttes to the 'divide' between Platte and Wind rivers along the Big Horn mountains the strata incline at very high angles 40° to 80° and in some instances are very nearly vertical. The true lignite strata seem to conform to the older fossiliferous rocks and to have been disturbed by the same influences that elevated the mountain ranges in the vicinity. These Tertiary beds extend over all the plain country to the north, and east of the Laramie mountains, far to the northward, beyond the limits of our explorations. Crossing the Wind River mountains, we find them largely developed high upon the western slope, dipping at a high angle, from the Wind River range on the one side, and the Wasatch and Green River mountains on the other.

Throughout the Wind River valley is a series of beds of great thickness which seem to be intermediate in their character between the true lignite beds and the White River Tertiary deposits. We first observed them gently inclined near Willow Springs on the North Platte and thence westward toward the Sweet Water mountains, and near the 'divide' between the North Platte and Wind River they reach a thickness of four hundred feet. From this 'divide' throughout the Wind River valley they occupy the greater portion of the country and though inclining in the same direction with the older strata the beds do not dip more than 1° to 5°. They differ from the other deposits in the great predominance of arenaceous sediments and in the absence of vegetable remains, but they contain fragments of turtles and

numerous fresh water and land shells of the genera *Helix*, *Planorbis*, *Vivipara*, etc. The entire thickness of these deposits may be estimated at from fifteen hundred to two thousand feet. From the fact that these deposits do not conform to the true lignite beds and that detached portions are seen lying upon the sides of the mountains but slightly inclined, while the corresponding beds are shown in the valley below, we infer that they were accumulated long before the mountains were raised to their present height or perhaps during the gradual process of elevation. This is especially shown at the upper end of the Wind River valley. Passing over the Wind River mountains we again see them holding the same position on the western slope and possessing the same lithological characters. While the lignite beds on the west side of the 'divide' incline at a large angle, the more recent beds although in some places occupying the very crest of the mountains, seldom incline more than 3 to 5 degrees.

The most interesting additional facts which we have obtained in regard to the White River Tertiary beds, are their geographical extension and the evidence of their age in relation to the lignite deposits. We can now show beyond a doubt that the former must have been accumulated long since the latter. We have ascertained that they extend southward along the Laramie Mountains to Willow Springs within ten miles of Cache la Poudre, that they also extend up the North Platte to the Box Elder creek, and even beyond are small outliers, showing that much has been removed by erosion. Passing over into the Laramie Plains we find at the source of the Box Elder and extending over to the head of Bates Fork a large development of this Tertiary and it also reaches far westward to the Medicine Bow mountains. We also know from the observations of Dr. Hines that it occupies a considerable area among the Sweet Water mountains extending over into the Green River valley. We have along the North Platte the overlapping of the White River beds upon the lignite strata, thus affording the evidence of superposition for their relative age. The same fact was noticed between the north fork of the Shyenne and the head of Cherry creek where beds of marl and limestone containing *Planorbis*, *Limnea*, etc., the same as are seen in the Bad Lands proper, repose upon true lignite Tertiary strata. Again, while the White River beds hold for the most part a horizontal position, those of the lignite Tertiary are often much disturbed. Near the Black Hills the former seem to have been elevated to a considerable heighth by the upheaval of the mountains, but they do not in any case incline more than 1° while north of the Black Hills the lignite beds dip 5° to 10°. Along the Platte I have seen the former inclining 5°, especially on La Bonte creek and about

fifteen miles east of the mouth of that creek. Often the beds seem to have been raised up several hundred feet above their original position, without inclination, resting upon the upturned edges of the lignite beds which we have before observed, partook equally of the disturbing influences which have given so great an inclination to the older fossiliferous rocks. Along the Big Horn mountains and the North Platte the lignite beds sometimes incline from the foot of the mountains 80° and often the influence of the elevatory power has affected them far out into the plain country.

In the above accounts of the Tertiary deposits of the West we have shown that the older members are clearly separated into four divisions exclusive of the Pliocene deposits of the Niobrara. Let us examine the evidence in regard to the age of these deposits. If we study the upper portions of Cretaceous formation No. 5 when not removed by the erosive power of water to any great extent, we then observe from the time we pass from No. 4 to No. 5 a gradual change in the sediments and other indications of a slow approach to shallow water, arenaceous sediments begin to take the place of argillaceous so that we have alternate thin layers of sand and clay, the sand continuing to increase until the upper part becomes a yellow ferruginous, coarse sandstone with most conspicuous examples of ripple-mark and oblique laminæ. As the waters of the Cretaceous bed were gradually receding, toward the Atlantic on the one side, and toward the Pacific on the other, remnants were here left in the form of lakes, estuaries, etc., which now afford us the last indications of marine and brackish water deposits in the central portions of the West. In these deposits we have first a mingling of brackish and fresh-water forms, gradually passing up to pure fresh-water and terrestrial species, with no return to the marine condition again.

In the upper part of the Cretaceous formation No. 5, on the Moreau, we find the *Ostrea subtrigonalis*, and in the Judith deposits a form occurs in the greatest abundance which is undistinguishable from it.

We have also mentioned the fact that the fossils of upper part No. 5 seem to have existed upon the verge of the Tertiary period, that they sometimes present peculiar forms more closely allied to Tertiary types than Cretaceous and were it not for the presence of the genera *Baculites, Ammonites, Inoceramus*, etc., which are every where supposed to have become extinct at the close of the Cretaceous epoch, we would be in doubt whether to pronounce them Tertiary or Cretaceous. These facts would seem to indicate a foreshadowing of the Tertiary era and that the transition from one great period to the other was gradual and quiet, the change in the physical conditions being ultimately sufficient to

destroy the Cretaceous fauna and bring into existence that of the Tertiary. Again, in numerous localities where No. 5 is fully developed and a large thickness of Tertiary deposits is superimposed, so that near some of the mountain elevations I have found it difficult to draw the line of separation, no apparent physical break occurring in the sediments.

Will not these statements go far to show that the estuary deposits ushered in the dawn of the Tertiary epoch and induce the belief that they belong to the first part or Eocene period? This point is an important one to establish, on account of its bearing upon the history of the physical development of our western continent.

The estuary deposits soon lose their marine and brackish character and gradually pass up into the true Lignite strata, of purely freshwater origin, thence by a slight discordancy into the Wind River valley beds, which give evidence of being an intermediate deposit between the true lignite and White river Tertiary beds. Then come the White river bone beds which pass up into the Pliocene of the Niobrara by a slight physical break, and the latter are lost in the Yellow Marl or Lacs deposits. I have estimated the entire thickness of Tertiary rocks in the Northwest at from five to six thousand feet, and their interest will be appreciated when I venture to suggest that by thorough investigation they will doubtless reveal in a most remarkably clear manner the history of the physical growth and development, step by step, of the central portion of this continent. I shall treat this subject more fully in a future paper, and would refer to the forthcoming Report of Capt. Raynolds for the details of the facts sustaining my opinions.

We have no evidence, so far as I know, of long continued deep-water deposits in the west, until far up in the Cretaceous period. If we examine the Potsdam sandstone we shall find that where it reaches its greatest force, the lower portion is composed of an aggregation of quartz pebbles cemented with siliceous matter, and as we pass upward we find it arranged in thin layers quite compact with fucoidal markings, ripple-mark, &c. Everywhere are most abundant examples of oblique laminæ of deposit, and ripple and wave-markings—evidences of shallow waters.

During the long period that elapsed between the deposition of the earliest part of the Silurian epoch and the commencement of the Carboniferous, we have reason to believe that dry land prevailed over a large portion of the west. The Carboniferous epoch commences with thin layers of arenaceous deposits gradually passing up into homogeneous siliceous and calcareous beds. The latter are never more than from twenty to fifty feet in thickness, and then the arenaceous sediments begin again to predominate and all the proofs of shallow as well as turbulent waters are shown. We then pass up through the red arenaceous de-

posits and Jurassic beds, and find no rocks that indicate deep water deposition. Cretaceous formation No. 1 commences in many places with a considerable thickness of an aggregation of water-worn pebbles passing up into thin alternate layers of arenaceous and argillaceous sediments with thick beds of sandstone with ripple markings and oblique laminæ, then gradually ceases in No. 2 and through Nos. 2, 3 and 4, the sediments indicate that they were accumulated in comparatively deep and quiet waters. No. 2 is a black plastic clay, No. 3 grey marl, and No. 4 a dark indurated sometimes laminated clay with many calcareous concretions. In No. 5 we gradually approach indications of shallow water until dry land appears, as already stated.

It will not be possible at this time to mention in detail all the oscillations of surface and other physical changes to which we have reason for supposing the country was subjected during all these periods. It is sufficient for our present purpose to show that except during the middle Cretaceous epoch no long continued periods of quiet water prevailed in these ancient western seas.

The evidence appears to me to point to the conclusion that a much milder climate prevailed throughout the western portions of our continent, during a greater part of the Tertiary period than that which exists in the same latitudes at the present time. The organic remains appear to indicate a subtropical climate or one similar to that of our Gulf States. Near the close of the Cretaceous epoch the waters of the great Cretaceous sea receded toward the present position of the Atlantic on the one side and toward that of the Pacific on the other, leaving large areas in the central portions of the west, dry land. These areas were of course proximity to the sea and comparatively but slightly elevated above the ocean waters. In regard to the Mollusca which have been found quite abundantly entombed in the lignite-bearing strata, it is an interesting fact that the most nearly allied living representatives of many of these species are now found inhabiting the streams of Southern Africa, Asia, China and Siam, apparently indicating the existence of a tropical climate in these latitudes at as late a period as the Tertiary epoch.*

Again, the luxuriance of the flora which has been so perfectly preserved in the lignite strata of the West point to the same conclusion. It is true that until recently no species have been found which belong exclusively to a tropical vegetation, but during our last expedition we obtained a species of true fan palm, very closely allied to *Sabal lamonis*, figured by Dr. Heer in his "Flora Tertiaria Helvetiæ." "The most northern limit of palms is that of *Chamærops palmetto*, in North America in lat. 34°–36°, and of *Chamærops humilis* in Europe, near Nice, in 43°–44° N.

* See Memoir by F. B. Meek and F. V. Hayden, in Proc. Pa. Acad., June, 1856.

lat."* The true palms of our present day are considered as having their native land within the tropics. That this or a similar condition of climate continued throughout the accumulation of the Wind River valley deposits may be inferred from their Molluscan remains which are more nearly allied to tropical forms.

Again, we have in the West, as before mentioned, a vast area occupied by the lignite-bearing strata. There are from thirty to fifty beds of lignite varying in thickness from one inch to seven feet. Over all this vast area there are at the present time no large forests, no timber except that which skirts the streams. We now know that during the Tertiary period vast forests of timber must have covered many portions of the West from the abundance and variety of the vegetable remains preserved in the rocks. Silicified trunks of trees, fifty to one hundred feet in length and two to four feet in diameter, and stumps which indicate gigantic forest trees occur abundantly over hundreds of square miles along the Missouri and Yellow Stone rivers. Prof. Henry and other meteorologists have arrived at the conclusion from a vast number of well authenticated facts that the absence of forest trees on the great prairies of the far west is due to the want of moisture which is well known to prevail all along the eastern slope of the Rocky Mountains. The prevailing winds are now known to come from the west, and as the currents of air ladened with moisture from the Pacific ascend the western slope of the mountains, become condensed and deposit their burdens for the most part before reaching the eastern slope.

Prof. Henry, in his paper on Climatology contributed to the Patent Office Report for 1856, says: "the return westerly current, sweeping over the Pacific Ocean, and consequently charged with moisture, will impinge on the Coast range of mountains of Oregon and California, and, in ascending its slopes, deposit moisture on the western declivity, giving fertility and a healthful climate to a narrow strip of country bordering on the ocean, and sterility to the eastern slope. All the moisture however will not be deposited in the passage over the first range, but a portion will be precipitated on the western side of the next, until it reaches the eastern elevated ridge of the Rocky Mountain system, when, we think, it will be nearly if not quite exhausted." We are now supposing that the climatic conditions, winds, currents of air, &c., did not differ to any great extent during the Tertiary epoch from those which prevail in the same latitudes at the present day. We therefore venture the suggestion that up to the time of the accumulation of the middle Tertiary deposits the lofty barrier of the Rocky Mountains did not exist.

* Lindley's Vegetable Kingdom, p. 136.

Washington, D. C., January 20, 1861.

ART. XXII.—*Remarks on the Atomic Weights of the Elements;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy in New York.

IN the present communication I shall endeavor to show that if the atomic weights of oxygen, sulphur and carbon are taken, respectively, as 16, 32 and 12, those of a majority of the other elements must be doubled. I do not at present adopt the view in question; my object is simply to point out the logical consistency of the change. For the sake of convenience and precision of language I shall employ the terms atom, molecule and equivalent, in the sense in which they are understood by the chemists of the new or unitary school.* An atom of any element is the least quantity of that element which can exist in combination: a molecule is the least quantity which can exist in the free state. The definitions of atomic and molecular weights flow at once from those of atom and molecule. The equivalents of bodies are the relative quantities which replace each other in actual or ideal substitutions; they may correspond to atoms or to molecules, or may bear a simple numerical relation to either of these. The atomic weights of carbon, oxygen and sulphur are now generally considered to be respectively 12, 16 and 32, chiefly upon the following grounds:

1. In all volatile organic compounds the constitution of which has been accurately determined, the number of atoms of these elements is always even, if we consider the weights of the atoms to be respectively 6, 8 and 16. Provided that all such compounds are assumed to correspond to 2 vols. of vapor ($H=1$).

2. Purely chemical considerations appear to show that in organic compounds, independently of any assumption as to vapor-volumes, the number of atoms of carbon, oxygen and sulphur is always even.

3. When oxygen or sulphur replace hydrogen in organic compounds, 2 units of weight of hydrogen are replaced by 16 of oxygen or 32 of sulphur; 4 units of hydrogen by 32 of oxygen, and so on; in no case is one unit of weight of hydrogen replaced by 8 of oxygen.

4. The least quantity of oxygen or sulphur set free in any reaction is either 32 or 64, or is some multiple of 32 or 64. In like manner the least quantity of oxygen or sulphur which reacts with any compound body is a multiple of 16 or 32 by an even number.

The assumption is now generally made that the molecules of all substances in the gaseous state occupy the same volume:

* See for example Kekulé, Lehrbuch der Organischen Chemie, i, 97, Erlangen, 1859.

from this it follows that in the greater number of cases two atoms unite to form one gaseous molecule. The difficulty which formerly existed in the case of sulphur has been completely removed by the researches of Deville and Troost, and of Bineau, who have shown that the volume occupied by 16 parts of sulphur in the form of perfect gas is $\frac{1}{2}$, and not $\frac{1}{6}$ of that occupied by 1 part by weight of hydrogen. In the case of those substances the vapor-densities of which correspond to *four* volumes, it appears probable that decomposition into two 2-volume molecules occurs, so that the observed vapor-densities are the sums of the densities of the constituent molecules. Thus sal-ammoniac* in the form of vapor is HCl and NH_3, these constituents recombining at a lower temperatute to NH_4Cl. In this manner, among others Kopp† and Hofmann‡ have shown that it is unnecessary to admit the existence of 3-volume, 4-volume and 6-volume vapors. There exists however at least one exception to the law now generally admitted that, in the case of the elements, one molecule consists of two associated atoms. The vapor-density of phosphorus, even at a temperature of 1040° C., corresponds to $\frac{1}{2}$ vol., the atomic weight being taken as 31. Since sulphur, which is less volatile than phosphorus, is a perfect gas even at 860°, we cannot admit that the case is otherwise with phosphorus, or reasonably suppose that the vapor-density would correspond to one volume if determined at a still higher temperature. We must therefore admit that the molecule of phosphorus corresponding to 2 vols. of vapor contains 4 atoms, and not 2 like that of nitrogen, while nothing is more certain than that the atomic weights of phosphorus and nitrogen are respectively 31 and 14. In like manner the vapor-density of arsenic appears also to correspond to $\frac{1}{2}$ volume only, though it has not yet been determined at temperatures very far above the boiling point.

If now we admit that the molecules of all substances occupy 2 vols. in the gaseous state, and if the reasoning which has led chemists to double the old atomic weights of carbon, oxygen, sulphur, &c., be correct, it follows that the atomic weights of the greater number of the elements must be doubled. For we find:—

1. That nearly all volatile inorganic oxyds, chlorids, oxychlorids &c. contain in 2 vols. of vapor (H=1) two or four received equivalents of metal or radical. Thus the compounds whose formulas are now usually written $SiCl_2$, $TiCl_2$, ZCl_2, $SnCl_2$,

* Deville and Troost have shown that sal-ammoniac corresponds to 4 vols. of vapor even at a temperature of 1040° C. At this temperature ammonia must be resolved into its elements, and its vapor-density ought to correspond to 6 vols. instead of 4. The explanation in the text is therefore not applicable to all cases. Comptes Rendus, xlix, 239.

† Ann. Chemie und Pharmacie, cv, 390.

‡ Comptes Rendus, xlix, 781.

HgCl, Hg_2Cl, HgBr, Hg_2Br_2, Fe_2Cl_3, Al_2Cl_3, Al_2I_3, Al_2Br_3, CrO_2Cl, must be written Si_2Cl_4, Ti_2Cl_4, Z_2Cl_4, Sn_2Cl_4, Hg_2Cl_2, Hg_4Cl_2, Hg_2Br_2, Hg_2I_2, Fe_4Cl_6, Al_4Cl_6, Al_4I_6, Al_4Br_6, $Cr_2O_4Cl_2$, in order to correspond to 2 vols. of vapor.

2. All volatile metals and metallic oxyds contain two or four received equivalents in 2 vols. of vapor. Thus the vapor-densities of mercury and cadmium represent the molecular weights Hg_2 and Cd_2. Arsenous and osmic acids correspond in the form of vapor to the formulas As_2O_6 and Os_2O_8.

3. All volatile compounds of metals with organic radicals contain an even number of equivalents of metal in 2 vols. of vapor, excepting only those in which triatomic metals occur. Thus we have corresponding to 2 vols. of vapor the formulas:—

$$\left.\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right\}Zn_2,\quad \left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}Zn_2,\quad \left\{C_2H_3\right\}_4Sn_2,\quad \left\{C_4H_5\right\}_4Sn_2,$$

$$\left.\begin{matrix}(C_2H_3)_2\\(C_4H_5)_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_2\\Cl_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_2\\Br_2\end{matrix}\right\}Sn_2,\quad \left.\begin{matrix}(C_4H_5)_3\\Br\end{matrix}\right\}Sn_2,$$

$$\left.\begin{matrix}(C_4H_5)_3\\Cl\end{matrix}\right\}Sn_2.$$

4. The volatile compounds of the triatomic radicals, nitrogen, phosphorus, arsenic, antimony, bismuth and boron, contain in 2 vols. of vapor only one received atomic weight of the radical. Thus we have the compounds:—

NH_3, PCl_3, $AsCl_3$, $SbCl_3$, $BiCl_3$, BCl_3, $P(C_4H_5)_3$, $As(C_4H_5)_3$, $Sb(C_4H_5)_3$, $B(C_4H_5)_3$, $BO_3\ 3C_4H_5O$, &c. &c.

To this there are exceptions. Thus we have corresponding to 2 vols. the formulas:—

$$As_2O_6,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2O_2,\quad \left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2S_2.$$

5. The specific heats of the atoms of nearly all the elements are equal if the molecule is in each case referred to 2 vols. of vapor.*

If now we consider it proved from the above considerations that the molecular weights of carbon, silicon, tin, titanium and zirconium, correspond in the gaseous form to 2 vols., and that these elements are tetratomic, it follows from analogy that certain other elements are also tetratomic, and we have the group:—

Carbon,	12	1·68	Lead,	208	6·52
Silicon,	28	—	Palladium,	108	6·40
Zirconium,	44	—	Rhodium,	102	5·62
Titanium,	48	—	Ruthenium,	106	—
Niobium,	96	—	Platinum,	198	6·40
Tantalum,	136	—	Iridium,	196	7·00
Tin,	116	6·52	Osmium,	194	5·92

* The only exception to this law occurs in the case of carbon, and cannot at present be explained.

The first column of numbers giving the atomic weights, the second the atomic heats or the products of the atomic weights into the specific heats. It is possible that thorium belongs to the tetratomic group, as thoria appears to be ismorphous with stannic acid, Sn_2O_4. Lead is placed in this group from the analogy of the compounds which it forms with ethyl, methyl, &c. to stannethyl, &c.: it appears however like tin, palladium, ruthenium, platinum, rhodium, iridium and osmium to be also diatomic; the so-called protoxyds having the formulas Pb_2O_2, Sn_2O_2, &c. For similar reasons we admit the existence of 6 triatomic elements, namely:—

Nitrogen,	14	—	Antimony,	120	6·11
Phosphorus,	31	5·85	Bismuth,	208	6·41
Arsenic,	75	6·10	Boron,	11	—

The diatomic elements, according to the reasoning above mentioned, will be 30 in number, and may be arranged in natural families, as follows:—

Oxygen,	16	—	Iron,	56	6·38
Sulphur,	32	6·48	Manganese,	54	—
Selenium,	80	6·08	Cobalt,	60	6·42
Tellurium,	128	6·08	Nickel,	58	6·28
———			Chromium,	52	—
Magnesium,	24	—	Aluminum,	27·5	5·88
Calcium,	40	—	Zinc,	65	6·24
Strontium,	88	—	Cadmium,	112	6·36
Barium,	136	—	Copper.	63	6·04
———			Uranium,	120	—
Cerium,	92	—	Mercury,	200	6·40
Lanthanum,	94	—	———		
Didymium,	96	—	Molybdenum,	96	6·91
Yttrium,	—	—	Tungsten,	184	6·67
Erbium,	—	—	Vanadium, ?	138	—
Terbium,	—	—	———		
Glucinum,	10	—			
Thorium, ?	118	—			

This classification into natural families appears to me to represent the present state of our knowledge, though the position of several elements must be regarded as doubtful.* The monatomic elements are only 10 in number; they may be arranged in three groups:

Chlorine,	35·5	—	Hydrogen,	1	—	Silver,	108	6·16
Bromine,	80	–6·74	Lithium,	7	—	Gold,	197	6·38
Iodine,	127	6·88	Sodium,	23	6·71			
Fluorine,	19	—	Potassium,	39	6·60			

* There is reason to believe that vanadium belongs with boron to the nitrogen group.

It is however to be remarked that, of the other elements, at least two, namely copper and mercury, are monatomic in certain combinations, as for example, in Cu_2Cl and Hg_2Cl. It is true that we may write these formulas Cu_4Cl_2 and Hg_4Cl_2, in which case we have two additional diatomic forms of copper and mercury with the atomic weights 126 and 400 respectively. This mode of viewing the subject obliges us to admit atomic heats represented nearly by the number 12, or twice as high as in the case of the other elements, and appears therefore less simple than that first stated.

In like manner all the elements belonging to the tetratomic group which form protoxyds, &c., may be regarded as tetratomic and diatomic; this will add at least eight to the number of diatomic elements. Finally, in the sesquioxyds and similar compounds two received atoms of iron, manganese, chromium, aluminum, &c., must be regarded as forming a single triatomic atom. Limpricht* and Frankland† admit the existence of pentatomic elements, including the nitrogen group in this class, but this view is not generally adopted, and in the present state of our knowledge a primary division of the 60 elements into four classes, the monatomic, diatomic, triatomic and tetratomic elements, appears to be sufficient.

From the above it appears that of the 60 elements now known to chemists, the received atomic weights of 50 at least must be doubled, if we admit the correctness of the reasoning which has led many chemists at the present day to double the atomic weights of carbon, oxygen and sulphur. Wanklyn‡ and Wurtz§ have already suggested the propriety of doubling the equivalents of zinc and tin, and by analogy, of several other metals, while Cannizzaro‖ has adduced the specific heats of the atoms with other arguments in favor of the same change. Wurtz compares oxyd of zinc Zn_2O_2, with oxyd of ethylene $(C_4H_4)O_2$; the hydrate of oxyd of zinc will then correspond to glycol, $\left.\begin{matrix}Zn_2\\H_2\end{matrix}\right\}O_4$. In the same way we may consider hydrate of sesquioxyd of iron as corresponding to glycerine, $\left.\begin{matrix}\overset{\prime\prime\prime}{Fe_2}\\H_3\end{matrix}\right\}O_6$ to $\left.\begin{matrix}\overset{\prime\prime\prime}{C_6H_5}\\H_3\end{matrix}\right\}O_6$, Fe_2 being here triatomic.

Should the further progress of the science show that the views above mentioned are the most simple and consistent expression

* Limpricht. Lehrbuch der Organischen Chemie, 1te Abth., 8.

† Quarterly Journal of the Chemical Society, vol. xiii, Nos. 2 and 3.

‡ The same, vol. xiii, p. 124.

§ Ann. de Chimie et de Physique, lx, 239, and Repertoire de Chimie pure, ii, 405.

‖ Il nuovo Cimento, vii, 321. I have not seen the original paper and quote at second hand from the Jahresbericht of Kopp and Will for 1858, p. 12.

of all the facts, it will be desirable to return to the notation of Berzelius slightly modified, that is to say, it will be better to halve the atomic weights of hydrogen and the other monatomic and triatomic elements, and denote the atomic weights of carbon, oxygen, sulphur, zinc, &c., by the numbers 6, 8, 16, 32,5, &c., respectively. In this manner while the formulas are written with precisely the notation of the new school, the numbers actually employed in the great majority of calculations will be those which have been sanctioned by longest usage, and which are most convenient for practical purposes. The atomic weights of hydrogen, chlorine, potassium, and the other monatomic elements, will be in each case one half of the old equivalent, while the molecular weights will correspond with the old equivalents. Thus we shall have:—

Hydrogen,	$\frac{1}{2}$	1	Oxygen,	8	16
Chlorine,	17·75	35·5	Carbon,	6	12
Bromine,	40	80	Zinc,	32·5	65
Potassium,	19·5	39	Iron,	28	56
Nitrogen,	7	14	&c. &c.		

in which table the first column gives the atomic and the second the molecular weights.

The formula of water thus becomes H_2O and its atomic weight 9; caustic potash is $\left.\begin{matrix}K\\H\end{matrix}\right\}O$ and its atomic weight 28; oxyd of zinc will be ZnO and its atomic weight 40·5; chlorhydric acid will be HCl and its atomic weight 18·25. The dashed symbols ~~H~~, ~~Cl~~, ~~K~~, &c., may also be employed, as in the Berzelian notation and would in many cases be extremely convenient.

All the typical formulas now so generally employed will be written as at present, the actual weights only being changed. The general acceptance of the views of the new school would be greatly facilitated by the adoption of the system of atomic weights here proposed.

In another paper I propose to discuss the question of the basicity of the elements with other points of special theoretical interest.

New York, Jan. 12th, 1861.

ART. XXIII.—*Abstract of a Meteorological Journal for the year* 1860, *kept at Marietta, Ohio:* lat. 39° 25′ N., and long. 4° 28′ W. of Washington City; by S. P. HILDRETH.—[Thirty-fourth annual report.]

MONTHS.	THERMOMETER. Mean.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain—inches.	Prevailing Winds.	BAROMETER. Maximum.	Minimum.	Range.
January, . . .	32°·66	61	3°	15	16	3·25	S.S.W., & N.	30·00	29·05	·95
February, . . .	35·00	71	2	16	13	1·25	S.S.W., & N.W.	29·75	28·55	1·20
March, . . .	44·13	71	16	18	13	1·08	S.S.E., & N.W.	29·55	29·00	·55
April, . . .	54·30	83	24	13	17	5·30	S.S.E., & N.	29·75	28·65	1·10
May, ...	65·50	91	39	13	18	2·88	E.S.E., & N.	29·58	29·10	·43
June, ...	68·03	94	44	15	15	2·01	S.S.E., & W.	29·70	28·83	·87
July, ...	73·68	95	49	16	15	5·87	E.S.E., & S.W.	29·60	29·08	·52
August, . . .	72·23	95	48	18	13	4·14	E.S.E., & N.	29·58	29·20	·38
September, . .	62·10	88	38	15	15	3·26	S.E., & N.	29·70	29·15	·55
October, . . .	62·17	84	33	16	15	4·35	S.S.W. & N.	29·65	28·95	·70
November, . . .	40·29	79	10	15	15	4·01	S.W., W., & N.W.	29·60	28·85	·75
December, . .	30·13	51	11	7	24	2·08	W.N.W., & E.	29·85	28·73	1·12

The mean temperature of the year is 53°·35. The amount of rain and melted snow is 39·58 inches.

Remarks on the year 1860.—This year has been characterized by several uncommon events in the meteorology of the climate, such as wide-spreading and destructive storms, with tornadoes of unprecedented violence sweeping every thing in their course from the face of the earth with the impetuosity and force of gunpowder, raising the question whether its main power was not derived from electricity, rather than from the winds. Some portions of the valley of the Ohio and of the Mississippi suffered immensely from these storms in the months of May and June, which periods seem to be more liable to such outbreaks of the elements than any other portions of the year. Setting aside these events, the year has been one of uncommon fertility and productiveness. The crops of grain and fruit were abundant and never excelled in quantity since the first settlement of the country. The health of the adult portion of the population has been good, uncommonly exempt from fevers; in place of which has prevailed a new form of the old and well known scarlet fever, or 'putrid sore throat,' chiefly confined to children, but of a most fatal and destructive type. Like the cholera, it appears to be epidemic in its character, and after a certain period will run its course and disappear from the land.

TEMPERATURE, AND REMARKS ON THE SEASONS.

Winter months.—The mean temperature of the winter is 32°·95, proving it to have been a very mild one, as it is sometimes as low as twenty-six degrees. The first week in January was the coldest of the winter, the temperature being below freezing all the time, and on the fifth at three degrees below zero. The Ohio river was closed for a few days above Marietta, but soon opened, leaving the navigation for steamboats free, the remainder of the winter. In ponds and the mouths of creeks, ice formed of the thickness of six or eight inches, and a plentiful supply was procured for summer use of this needful article of comfort. The greatest depth of snow, at any one time, was three inches, on the 21st of December.

Spring.—The mean of the spring months was 54°·64, which is about the average for a series of years. This season is called earlier or later from the blossoming of a certain class of trees, especially fruit trees, the peach and apple being the standard. The former did not bloom until the eighth of April, and the latter on the fifteenth of that month, which may be called about the mean time, although the period varies as much as twenty-five or thirty days in some years. It was a spring of mild, pleasant temperature, and favorable to the growth and health of the vegetable kingdom, but marked by several unusual phenomena in the meteorological department of nature. The early part of April was attended with excessive rains, producing floods in the Ohio and Muskingum rivers, overflowing the bottom lands to a great depth, and higher by four feet at Dresden and two feet at Zanesville, than ever before. The main source of the flood was in the rivers that fall into the Ohio, on the north side, as the Scioto, Muskingum, Beaver and Alleghany. The southern affluents were not very high, or the water would have equalled that of 1832. But little damage was done below Marietta, which, standing at the junction of the Muskingum with the Ohio, suffers more than any other point ten miles above or below that place. At this town the water was four feet below the flood of 1832, but twelve inches higher than any other one.

Great meteor of May, 1860.—On the first day of May, about twenty minutes before one o'clock, P. M., a tremendous explosion was heard at Marietta, like the discharge of a piece of heavy artillery, the sound coming from the north. It was found to proceed from the explosion of an aërolite or meteor, which fell at a place about fifty miles north of Marietta, and twenty east of Zanesville. Its course with a description of the accompanying phenomena has been given in this Journal by Profs. Andrews and Evans of the Marietta College, and Dr. J. L. Smith; the first and last named gentlemen having personally visited the locality

where it fell, a few days subsequently, and minutely examined all the attending circumstances noted by the inhabitants in the vicinity. One of the largest fragments, weighing over one hundred pounds, was purchased and placed in the cabinet of Marietta College. Appearing, as this meteor did, in the middle of the day, when hundreds of spectators were in situations to see it, the history of its course and appearance has happily been made out more accurately and satisfactorily than that of any other which has visited North America.

Great storm of the 21*st of May.*—On Monday, the twenty-first day of May, the valley of the Ohio was visited by one of the greatest storms or tornadoes ever experienced since the settlement of the country. Commencing west of the Mississippi river, it swept over a space not less than six or seven hundred miles in length by fifty or sixty in breadth, following generally the course of the Ohio river, or from the southwest to the northeast. I do not know the hour of its commencement, but it was at Louisville, Ky., by two o'clock, P. M., at Cincinnati by half past three, at Portsmouth by half past four, and at Marietta about half past five, travelling at the rate of eighty or one hundred miles an hour, far exceeding in rapidity that of any railway train. Its progress was marked by desolation and ruin, in the destruction of buildings, fences, trees and boats. Of the latter, many coal boats were sunk and the navigators drowned. Several hundred lives were lost. Steamboats suffered less, as by their motive power they were able to gain a more sheltered position on the bends of the river. Louisville, Cincinnati and Portsmouth suffered more than any other towns, being larger and more fully exposed to the fury of the storm. Marietta suffered but little, the force of the tornado being expended before it reached that place. In its full force it was attended with thunder, lightning, hail and torrents of rain, pouring from the clouds more like a cataract than rain. The air was filled with leaves, fragments of branches and broken pieces of buildings, which, with the mist, produced a darkness equal to that of a cloudy night, requiring the aid of candles to go about the house. The violence of the storm at any one place did not last over half an hour. At Marietta the day was cloudy with a brisk breeze from the southwest in the forenoon, in the afternoon it veered to the south. At 5 P. M. heavy dark clouds appeared in the west, with a good deal of commotion and some thunder. At half past five it began to rain a little. A quarter before six, wind very violent from the southwest and west, with hard rain, blowing steadily and not in gusts as in ordinary storms, lasting about twenty minutes. As soon as the rain ceased, the sky or hazy clouds in the west and southwest put on a deep orange or copper color, and after seven until dark, a brilliant red, like the rays of light

in the aurora borealis. The night following was calm and clear. The mercury in the barometer, in the forenoon, was 29·10, and kept rising during the violence of the tempest, being at 29·15 at 5 P. M., and at 29·23 at 9 o'clock. At Wheeling, Va., 80 miles southeast of Marietta, there was only an ordinary gale, its force being spent before reaching there. No similar tornado has visited the valley of the Ohio since Sunday, the 28th day of May, 1809. This struck Marietta about 4 o'clock P. M. with more violence than in 1860. There was little or no rain or thunder; several houses were unroofed and some blown down, with immense destruction of forest trees. It was greater in breadth and probably as extensive as that of this year. I was living in the town at that time and witnessed its ravages. Brown's Cincinnati Almanac for the year 1810 contains the only printed account of it that I have seen; but probably the newspapers of that period noticed it, as there were then nine or ten published in Ohio.

Summer.—The mean of the summer months was 71°·31, which is a full average for this season of the year. Heat and moisture were distributed by a beneficent Providence in due season and in quantities fully adequate to the wants of vegetation, producing one of the most abundant harvests in all the various varieties of cereal productions common to this climate. In some of the southern counties whole fields of wheat were destroyed by that pernicious insect, *Tinea granella*, after it had attained its full growth. This miller is a different insect from the Hessian fly; the ravages of the former are confined to the grain, where it deposits its eggs when in the milk, while the 'fly' makes its attacks on the culm, laying its eggs in the autumn and spring. This miller in some districts, especially in Washington county, was very injurious, its larvæ devouring the grain in whole fields, leaving none for the farmer. Happily its ravages were limited. A remedy is said to be found in a new variety of wheat, which the Tinea does not molest, and which is already coming into cultivation. The meadows furnished an abundance of grass, and the pastures were green until late in the autumn. In some fields the potatoes suffered from the disease called 'the rot,' but generally the crop was abundant and good.

Autumn.—The mean of the autumnal months was 54°·85, a temperature adequate to the wants of the season. Indian corn, the main crop of the valley of the Ohio, and of more importance to the farmer than that of any other grain, was very abundant in quantity and excellent in quality. It ripened early, and was ready to be cut up by the twentieth of September. This year, from the supply of rains at the right time, the crops on the hills and uplands were nearly as good as in the rich bottom lands of the rivers, while on the latter, the heavy deposits of vegetable mould left by the overflow in April added unusual fer-

tility to the soil, producing crops of corn from eighty to one hundred bushels an acre, remunerating the husbandman for his extra labor in replowing and replanting his fields. Fruit of all kinds was abundant, especially apples and peaches. All the smaller fruits were in great perfection. Grapes matured without much loss from mildew or insects. Melons were never better or more plentiful. The forests abounded in acorns and nuts, bending their branches under their uncommon load. On every department of the vegetable kingdom the God of nature has bestowed his blessing in a manner rarely before witnessed.

Floral calendar.—February 24th, the Robin appears in flocks; 27th, Bluebirds.—March 1st, Blackbirds in flocks, yellow crocus in bloom; 7th, flocks of the cherry lark, White Crocus; 14th, Persian Iris; 16th, blue Crocus; 20th, Crown Imperial nearly open; 25th, Sugar maple; 26th, Golden bell or Forsythia viridis; 28th, Magnolia conspicua ready to open, but injured by the late frosts.—April 1st, Primrose in bloom; 3d, Hyacinth; 6th, Peach partly open in warm exposures; 7th, Sanguinaria canadensis; 8th, Peach in full bloom, Plum trees, Pears and Cherries; 11th, white Narcissus; 15th, Apple tree in bloom; 16th, Red-bud or Circis canadensis, Hydrastis canadensis; 18th, Cornus Florida; 23d, Lilac; 26th, Tulips in bloom.—May 1st, Black Haw tree in bloom; 2d, Quince tree, Harebell; 5th, Native crab apple; 7th, Horse chestnut; 8th, Wigelia rosea; 11th, Harrison yellow rose and fragrant Syringa; 13th, Locust or Pseudoaensia; 14th, Prunus Virginiana; 25th, Syringa Philadelphia.—June 10th, White Lily; 17th, Catalpa tree; 30th, Juneating apple ripe.—July 5th, Amaryllis formosa; 7th, Blackberry ripe; 8th, American broom in bloom; 12th, Chestnut tree.—August 1st, Green gage plum ripe, and Summer Virgaleu pear; 8th, Watermelons ripe in open ground; 16th, Sweet potatoes in market.

Marietta, Ohio, January 1, 1861.

ART. XXIV.—*On the Theory of Types in Chemistry;* by T. STERRY HUNT, F.R.S.

IN the *Annalen der Chimie und Pharmacie* for March, 1860 (cxiii, 293), Kolbe has given a paper on the natural relations between mineral and organic compounds, considered as a scientific basis for a new classification of the latter. He objects to the four types admitted by Gerhardt, (namely, hydrogen, hydrochloric acid, water and ammonia,) that they sustain to organic compounds only artificial and external relations, while he conceives that between these and certain other bodies there are natural relations having reference to the origin of the organic spe-

cies. Starting from the fact that all the carbon compounds found in the vegetable kingdom are derived from carbonic acid with the concurrence of water, he proceeds to show how all the bodies of the carbon series may be deduced from an oxyd of carbon, which is either carbonic acid, carbonic oxyd, or the hypothetical C_2O.

When in the former (C_2O_4) we replace an atom of oxygen by one of hydrogen we have C_2O_3H, or anhydrous formic acid; the replacement of a second equivalent would yield $C_2O_2H_2$, or the unknown formic aldehyd; a third, C_2OH_3, the oxyd of methyl, and a fourth, C_2H_4, or formene. By substituting methyl, C_2H_3, for one or more atoms of hydrogen in the preceding formulas we obtain those of the corresponding bodies of the vinic series, and it will be readily seen that by introducing the higher alcoholic radicals we may derive from C_2O_4 the formulas of all the alcoholic series. A grave objection to this view is however found in the fact that while the anhydrid may in this way be made the type of the aldehyds, acetones and hydrocarbons, it becomes necessary to assume the hypothetical C_2O_4HO as the type of the acids and alcohols. Oxyd of carbon, C_2O_2, is according to Kolbe to be received as the type of hydrocarbons like olefiant gas, ($C_2H.C_2H_3$,) while C_2O, in which ethyl replaces oxygen is C_6H_5 or lipyle, the supposed triatomic base of glycerine.

The monobasic organic acids are thus derived from a single molecule of carbonic acid, while bibasic acids like the succinic are by Kolbe deduced from a double molecule, and tribasic acids like citric from a triple molecule, C_6O_{12}. He moreover compares sulphuric acid to carbonic acid and deduces from it by substitution the various sulphuric organic compounds. Ammonia, phosphuretted and arseniuretted hydrogen are regarded as so many types, and by an extension of his view of the replacement of oxygen by electro-positive groups the ethylids like ZnEt, $PbEt_2$, and $BiEt_3$, are by Kolbe assimilated to the oxyds, ZnO, PbO_2, and BiO_3.*

Ad. Wurtz, in the *Repertoire de Chimie Pure* for October, 1860, has given an analysis of Kolbe's memoir (to which, not having the original before me, I am indebted for the above sketch), and follows it by a judicious criticism. While Kolbe introduces as types a number of mineral species, including the oxyds of carbon, sulphur, and the metals, Wurtz would maintain but three, hydrogen (H_2), water (H_2O_2), and ammonia (NH_3), and these three types, as he endeavored to show in 1855, represent different degrees of condensation of matter. The molecule of hydrogen, H_2 or M_2, corresponding to four volumes, combines with

* See on this subject Dr. Frankland's late excellent lecture on Organo-metallic bodies in the Quarterly Journal of the Chemical Society, July, 1860, Nos. L, LI.

two volumes of oxygen (O_2) to form four volumes of water, and may thus be regarded as condensed one-half in its union with oxygen, and derived from a double molecule, M_2M_2. In like manner four volumes of ammonia, NH_3, contain two volumes of nitrogen and six of hydrogen, which being reduced to one-third corresponds to a triple molecule, M_3M_3, so that these three types and their multiples are reducible to that of hydrogen more or less condensed.—(Wurtz, *Ann. de Chimie et de Physique*, [3], xliv, 302.)

As regards the rejection of water as a type of organic compounds and the substitution of carbonic acid, founded upon the consideration that these bodies in nature are derived from C_2O_4, Wurtz has well remarked that water, as the source of hydrogen, is equally essential to their formation, and farther that the carbonic anhydrid, like all other anhydrous acids, may be regarded as a simple derivative of the water type. Having then adopted the notion of referring a great variety of bodies to a mineral species of simple constitution, water is to be preferred to carbonic acid, 1st, because we can compare with it many mineral compounds which can with difficulty be compared with carbonic acid, and 2d, because the two atoms of hydrogen in water being replaceable singly, the mode of derivation of a great number of compounds (acids, alcohols, ethers, etc.) is much more simple and natural than from carbonic acid. As Wurtz remarks, Kolbe has so fully adopted the theory of types that he wishes to multiply them, and even admits condensed types, which are, however, molecules of carbonic acid and not of water; "he combats the types of Gerhardt and at the same time counterfeits them."

Thus far we are in accordance with Wurtz, who has shown himself one of the ablest and most intelligent expounders of the doctrine of molecular types as above defined, now almost universally admitted by chemists. He writes, "to my mind the idea of referring to water, taken as a type, a very great number of compounds is one of the most beautiful conceptions of modern chemistry;" and again he declares the idea of regarding water and ammonia as representatives of the hydrogen type more or less condensed, to be so simple and so general in its application that it is worthy "to form the basis of a system of chemistry." (*Repertoire de Chimie Pure*, 1860, pp. 356–359.)

We have here two important conceptions; the first is that of hydrogen and water regarded as types to which both mineral and organic species may be referred, and the second is the notion of condensed and derived types, according to which we not only assume two or three molecules of hydrogen, water or ammonia as typical forms, but even look upon water as the derivative of hydrogen, which is itself the primal type.

As to the history of these ideas, Wurtz remarks that the proposition enunciated by Kolbe that "all organic bodies are derived from mineral compounds, from which they take their origin, in part directly, by processes of substitution of great simplicity," is not new, but "known in the science for about ten years. Williamson was the first who said 'alcohol, ether and acetic acid are compounds comparable to water, organic waters.' Hofmann and myself had already compared the compound ammonias to ammonia itself. * * * To Gerhardt belongs the merit of generalizing these ideas, of developing them, and supporting them with his beautiful discovery of anhydrous organic monobasic acids. Although he did not introduce into the science the idea of types, which belongs to Dumas, he gave it a new form, which is expressed and essentially reproduced by the proposition of Kolbe." "Gerhardt reduced all organic bodies to four types, hydrogen, hydrochloric acid, water and ammonia." (*Repertoire, etc.*, p. 355.)

The historical inaccuracies of the passage just quoted are the more surprising, since in March, 1854, I published in this Journal ([2], xvii, 194,) a concise account of the progress of these views. This paper was republished in the *Chemical Gazette* (1854, p. 181), and copies of it were by myself placed in the hands of most of the prominent chemists of England, France and Germany. In this paper I have shown that the germ of this idea of mineral types is to be found in an essay by Auguste Laurent, (*Sur les combinaisons azoteés, Ann. de Chimie et de Physique*, Nov. 1846,) where he showed that alcohol may be looked upon as water H_2O_2 in which ethyl (C_4H_5) replaces one atom of hydrogen, while hydric ether is the result of a complete substitution of the hydrogen by a second atom of ethyl. Hence he observed that while ether is neutral, alcohol is monobasic and the type of the monobasic vinic acids, as water is the type of bibasic acids. In extending and developing this idea of Laurent's I insisted in March, 1848, and again in January, 1850, upon the relations between the alcohols and water as one of homology, water being the first term in the series, and H_2 in like manner the homologue of formene and acetene, while the bases of Wurtz were said to sustain to their corresponding alcohols the same relation that ammonia does to water. (This Journal, v, 265, ix, 65.)

In a notice of his essay published in September, 1848, (Ibid, vi, 173,) I endeavored to show that Laurent's view might be farther extended so as to include in the type of water, "all those saline combinations (acids) which contain oxygen," and in a paper read before the American Association for the Advancement of Science, at Philadelphia in Sept. 1848, I farther suggested that as many neutral oxygenized compounds which do

not possess a saline character are derivatives of acids which are referrable to the type H_2O_2, "we may regard all oxygenated bodies as belonging to the type H_2O_2," which as I farther showed in the same essay is but a derivative of the primal type H_2, to which I referred all hydrocarbons and their chlorinized derivatives, as also the volatile alkaloids, which were regarded "as amidized species" of the hydrocarbons, in which the residue amidogen, NH_2, replaced an atom of H or Cl, or what is equivalent, the residue NH took the place of O_2 in the corresponding alcohols. (Ibid., viii, 92.)

In the paper published in Sept. 1848, I showed that while water is bibasic, the acids which like hypochlorous and nitric acids are derived from it by a substitution of Cl and NO_4 for H, are necessarily monobasic, and I then pointed out the possible existence of the nitric anhydrid $(NO_4)_2O_2$, the result of a complete substitution, which was soon after discovered by Deville. Gerhardt at this time denied the existence of anhydrids of monobasic acids; he regarded anhydrids as characteristic of polybasic acids, and indeed was only lead to adopt my views by the discovery of the very anhydrids whose formation I had foreseen.*

In explaining the origin of bibasic acids I described them as produced by the replacement in a second equivalent of water of an atom of hydrogen by a monobasic saline group; thus sulphuric acid would be $(S_2HO_6H)O_2$. Tribasic acids in like manner were regarded as derived from a third equivalent of water in which a bibasic residue replaces an atom of hydrogen. The idea of polymeric types was still farther illustrated in the same paper where three hydrogen types were proposed, (HH), (H_2H_2) and (H_3H_3), corresponding to the chlorids MCl, MCl_3, and MCl_5. (This Journal, vi, 174.)

I also showed that hydrogen is to be looked upon as the fundamental type, from which the water type is derived by the replacement of an atom of hydrogen by the residue HO_2; thus $(HO_2 . H)$, (Ibid, viii, 93). In the same way I regarded ammonia as water in which the residue NH replaced O_2.

I farther pointed out that sulphur in its ordinary state was to be regarded as a triple molecule, S_3 (or S_6=4 volumes), and referred sulphurous acid, SO_2 (S_2O_4), to this type to which also belongs selenic oxyd. At the same time I suggested that the odorant form of oxygen, ozone might be O_3. Wurtz has since adopted sulphur vapor at 400° C. or S_6 as the type of the triple

* The anhydrids of the monobasic acids correspond to two equivalents of the acid minus one equivalent of water, as $2(NHO_6)-H_2O_2=N_3O_{10}$, while those of the bibasic acids are formed from one equivalent of the acid by a similar elimination of an equivalent of water, thus $C_2H_2O_6-H_2O_2=C_2O_4$. Hence both classes of anhydrids are to be referred to the type of one molecule of water, H_2O_2.

molecule.—(*Ann. de Chim. et de Phys.*, xliv, 310.) In the same paper I suggested that gaseous nitrogen was to be regarded as an anhydrid amid, or nitryl, which may be derived from nitrite of ammonia as nitrous oxyd is from the nitrate, thus $(NO_3.NH_4O)-4HO=NN$.*—(This Journal, v, 408, vi, 172.) A late writer attributes this view to Gerhardt, who adopted it from me.

I have always protested against the view which regards the so-called rational formulas as expressing in any way the real structure of the bodies thus represented. These formulas are invented to explain a certain class of reactions, and we may construct from other points of view other rational formulas which are equally admissible.

As I have elsewhere said "the various hypotheses of copulates and radicals are based on the notion of dualism, which has no other foundation than the observed order of generation, and can have no place in the theory of the science." All chemical changes are reducible to union (identification,) and division (differentiation). When in these changes only one species is concerned, we designate the process as metamorphosis, which may be by condensation or by expansion (homogeneous differentiation). In metagenesis on the contrary unlike species may unite, and by a subsequent heterogeneous differentiation give rise to new species, constituting what is called double decomposition, the results of which, differently interpreted, have given origin to the hypothesis of radicals and the notion of substitution by residues to express the relations between the parent species and their progeny. The chemical history of bodies is a record of their changes; it is in fact their genealogy, and in making use of typical formulas to indicate the derivation of chemical species we should endeavor to show their ordinary modes of generation. (See *On the theory of chemical changes*, this Journal, xv, 226; *L. E. & D. Phil. Mag.*, [4], v, 526, and *Chem. Centralblatt*, 1853, p. 849, also *Thoughts on solution*, this Journal, xix, 100, and *Chem. Gazette*, 1855, p. 92.)

Keeping this principle in mind, let us now examine the theory of the formation of acids. As we have just seen, I taught in 1848 that the monobasic, bibasic and tribasic acids are derived respectively from one, two and three molecules of water, H_2O_2. Mr. Wurtz in 1855 put forth a similar view. He supposes a monatomic radical $PO_4{}'$, a diatomic radical $PO_3{}''$, and a triatomic radical $PO_2{}'''$ replacing respectively one, two and three atoms of hydrogen in H_2O_2, H_4O_4, and H_6O_6; thus $(PO_4{}'H)O_2$ $(PO_3{}''H_2)O_4$, and $(PO_2{}'''H_3)O_6$. These radicals evidently correspond to PO_5 which has lost one, two and three atoms of ox-

* May not nitrogen, as we have elsewhere suggested, under certain conditions regenerate ammonia and a nitrite, and may not this reaction enter into certain processes of nitrification? I propose at an early day to consider this question.

ygen in reacting upon the hydrogen of the water type, and the acids may be accordingly represented as found by the substitution of the residue PO_5-O, for H, etc.

To this manner of representing the generation of polybasic acids we object that it encumbers the science with numerous hypothetical radicals,* and moreover fails to show the actual successive generation of the series of acids in question. When phosphoric anhydrid $P_2O_{10}=(PO_4)_2O_2$ is placed in contact with water it combines with one equivalent, H_2O_2. The union is followed by homogeneous differentiation, and two equivalents of metaphosphoric acid result; $(PO_4)_2O_2+H_2O_2=2(PO_4H)O_2$. Two equivalents of this acid in contact with one of water at common temperatures are slowly transformed into two of pyrophosphoric acid, by a reaction precisely similar to the last; $2(PHO_6)=(PHO_5)_2O_2+H_2O_2=2(PHO_5.H)O_2$; and two equivalents of pyrophosphoric acid when heated with a third equivalent of water yield in like manner two of tribasic phosphoric acid; $2(PH_2O_7)=(PH_2O_6)_2O_2+H_2O_2=2(PH_2O_6.H)O_2=2PH_3O_8$.

The above, which we conceive to be a simple statement of the process as it takes place in nature, dispenses alike with hypothetical radicals and residues, both of which are however convenient for the purposes of notation. In the selection of a typical form to which a great number of compounds may be referred, hydrogen or water, from its simplicity, as already remarked by Wurtz, and also from the important part which it plays in the generation of species, merits the preference. Water and carbonic acid are both so directly concerned in the generation of the bodies of the carbon series, that either may be assumed as the type, but we prefer to regard C_2O_4 like all the other anhydrids as a derivative of water and eventually of the hydrogen type.

These views were first put forward by myself in 1848, when I expressed the opinion that they were "destined to form the basis of a true natural system of chemical classification," and it was only after having for four years opposed them to those of Gerhardt, that this chemist in June, 1852, renounced his former views, and without any acknowledgment, adopted my own (*Ann. de Chimie et de Physique* [3], xxxvii, 285). Already in 1851, Williamson in a paper read before the British Association developed the ideas relative to the water type to which Wurtz refers above, and to Williamson the English editor of Gmelin's

* Those who are familiar with chemical literature will remember an amusing *jeu d'esprit* of the lamented Laurent in which he invited the attention of the advocates of the radical theory to a new electro-negative radical which he named Eurhizene, (*Comptes Rendus des Travaux de Chemie*, 1850, pp. 251 and 376). It was not without a smile that we observed a late writer in *The Chemical News*, vol. i, 326, proposing as a newly invented radical under the name of hydrine, the peroxyd of hydrogen HO_2, the eurhizene of Laurent!

Handbook, ascribes the theory. The notion of condensed types, and of hydrogen as the primal type, was not so far as I am aware brought forward by either of these, and remained unnoticed until resuscitated by Wurtz in 1855, seven years after I had first announced it, and one year after my reclamation published in this Journal in March, 1854.

My claims have not however been overlooked by Dr. Wolcott Gibbs; in an essay on the polyacid bases, he remarks that in a previous paper he had attributed the theory of water types to Williamson and Gerhardt, and adds "in this I find I have not done justice to Mr. T. Sterry Hunt, to whom is exclusively due the credit of having first applied the theory to the so-called oxygen acids and to the anhydrids, and in whose earlier papers may be found the germs of most of the ideas on classification usually attributed to Gerhardt and his school." (Proc. Amer. Assoc. for the Advancement of Science, Baltimore, May, 1858, p. 197.)

It will be seen from what precedes that I not only applied the theory, as Dr. Gibbs says, but except so far as Laurent's suggestion goes, invented it and published it in all its details some years before it was accepted by a single chemist.

In conclusion I have only to ask that future historians will do justice to the memory of Auguste Laurent, and will ascribe to whom it is due the merit of having given to the science a theory which has exercised such an important influence on modern chemical speculation and research, remembering that my own publications on the subject, which cover the whole ground, were some years earlier than those of Williamson, Gerhardt, Wurtz or Kolbe.

Montreal, Canada, Jan. 5, 1861.

Note to Mr. Hunt's paper on Types.—Gerhardt long since maintained that we can not distinguish between polybasic salts and what are called subsalts, which are as truly neutral salts of a particular type. Thus the bibasic and tribasic phosphates are to be looked upon as subsalts which sustain the same relation to the monobasic phosphates that the basic nitrates bear to the neutral nitrates. He succeeded in preparing two crystalline subnitrates of lead and copper, having the formulas $NO_5 . M_2O_2 . HO$ (tribasic), and $NO_5 . M_4O_4 . H_3O_3$ (quadri or septabasic), both of which retain their water of composition at 392° F. The compounds of sulphuric acid are, 1st, the true monobasic sulphate, $S_2O_6 . MO$, corresponding to the Nordhausen acid and to the anhydrous bisulphates. 2d, the ordinary neutral sulphate, $S_2O_6 . M_2O_2$. 3d, the so-called disulphates, $S_2O_6 . M_4O_4$, corresponding to the crystallized or glacial acid, density 1·780; 4th, the sulphates, $S_2O_6 . M_6O_6$, represented by turpeth mineral; and, 5th, the so-called quadribasic sulphate, $S_2O_6 . M_8O_8$. The copper salt of this type, according to Gerhardt, retains moreover 6HO at 392° F. Without counting the still more basic sulphates of zinc and

copper described by Kane and Schindler, we have a monobasic sulphate, *a*, S_2HO_7; a bibasic, *b*, $S_2H_2O_8$; a quadribasic, *c*, $S_2H_4O_{10}$; a sexbasic, *d*, $S_2H_6O_{12}$; and an octobasic, *e*, $S_2H_8O_{14}$. (*Gerhardt on Salts, Jour. de Pharmacie*, 1848, vol. xii, and this Jour., vi, 336.) These salts, in accordance with Wurtz's notation, correspond to the following radicals: *a*, S_2O_5, monatomic; *b*, S_2O_4, diatomic; *c*, S_2O_2, quadri-tetratomic; *d*, S_2, hexatomic; and *e*, S_2-O_{10}, octo-atomic. It is easy to apply a similar *reductio ad absurdum* to the radical theory in the case of the oxychlorids and other basic salts and to show that the radicals of the dualists are often merely algebraical expressions. (See farther my remarks, this Journal, vii, pp. 102–104.)

ART. XXV.—*Description of three new Meteorites.—Lincoln County Meteoric stone which fell in August*, 1855—*Oldham County* (*Ky.*) *Meteoric Iron—Robertson County* (*Tenn.*) *Meteoric Iron;* by J. LAWRENCE SMITH, M.D., Prof. Chem. Med. University of Louisville.

LINCOLN COUNTY METEORITE.—This meteorite was examined several years ago having been sent to me for that purpose by Prof. J. M. Safford, State Geologist of Tennessee; the result of my examination was embodied in Prof. Safford's report of the geology of Tennessee for 1855, but has never received a special notice in any scientific journal, and as it is not too late to make up that deficiency, the following is sent for publication, embracing Prof. Safford's account of its fall with the chemical examination. The following particulars in regard to its fall were furnished by the Rev. T. C. Blake of Cumberland University.

"It fell two miles west of Petersburg, and fifteen northwest of Fayetteville, in Lincoln county, about half-past three o'clock, P. M., August 5th, 1855, during, or just before, a severe rainstorm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five lesser reports; these were heard by many persons in the surrounding country. Immediately after, this mass or fragment was seen by James B. Dooley, Esq., to fall to the ground. It approached him from the east, appeared, while falling, to be surrounded by a "milky" halo, two feet in diameter, and fell one hundred and fifty or two hundred yards from him, burying itself about eighteen inches in the soil. When first dug out, it was too hot to be handled.

This specimen has an edge broken off, revealing the character of the interior. Within it is of an ashen-gray color, varied by patches of white, yellowish and dark minerals.

With the exception of the broken edge, it is covered, and when first obtained was entirely covered, as most meteorites of

this kind are, with a very 'black, shining crust, as if it had been coated with pitch.'

One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging 2¾ by 2½ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form approaching roughly an oblique pyramid. The length from the base to the apex is 4½ inches.

Three adjacent sides are rough, being covered with cavities and pits. The other sides are smoother and rounded.

The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3·20. Its weight, in its present condition, 3 lbs., 14¼ oz.

The minerals found in the meteorite are:

Pyroxene—principal portion of the mass;

Olivine and orthoclase—disseminated through the mass;

Nickeliferous iron—forming about one half per cent of the mass.

In addition to these, there are specks of a black, shining mineral, not yet examined."

The general analysis is as follows:

Silica	49·21
Alumina	11·05
Protoxyd of iron	20·41
Lime	9·01
Magnesia	8·13
Manganese	.04
Iron	·50
Nickel	minute quantity.
Phosphorus	" "
Sulphur	·06
Soda	·82
	99·23

The minute quantity of nickel that was separated did not permit of my examining for cobalt, but there is no doubt that this metal was present.

Oldham County Meteorite.—The announcement of the discovery of this iron meteorite with the one that follows was made in a note in the last number of this Journal.

It was discovered in the month of October 1860, by Mr. Wm. Daring near Lagrange, in Oldham County, Ky. There is nothing known with reference to the time of its fall. It came into my possession shortly after its discovery.

It was entire and weighed *one hundred and twelve pounds.* Its extreme dimensions were, length twenty, breadth ten and three-

fourths, and thickness six and a half inches; its shape was elongated and flattened. Its specific weight is 7·89 and an analysis furnished

Iron	91·21
Nickel	7·81
Cobalt	·25
Copper	minute quantity not estimated.
Phosphorus	·05
	99·32

ROBERTSON COUNTY METEORITE.—This mass of meteoric iron came into my possession during the month of December, 1860, being sent by Prof. Lindsley of Nashville, Tenn. It was discovered by Mr. D. Crockett, near Coopertown, in Robertson county, Tenn. The time of its fall is not known.

Its weight was *thirty-seven pounds*, its form was wedge-shaped, and its extreme dimensions, length ten, breadth nine and a half, thickness five and a half inches. Its specific gravity is 7·85. On cutting through the mass, a module of sulphuret of iron was discovered about ¼th inch in diameter, and there are doubtless others in its interior. The iron on analysis furnished

Iron	89·59
Nickel	9·12
Cobalt	·35
Copper	minute quantity not estimated.
Phosphorus	·04
	99·10

Louisville, January 29, 1861.

ART. XXVI.—*Correspondence of Mr. Jerome Nicklès, dated Nancy, December 5th*, 1860.

Obituary.—Since my last communication, France has lost three savans, one of whom was one of the oldest members of the Institute, and another one of the youngest. Of these two, the first is M. Duméril the zoologist, the second the botanist, Payer. The third is the hydrographer, M. Daussy, who many years since became unknown to science, and who is therefore least known of the three. He died the same day as M. Payer, viz., the 5th of September.

Duméril.—DUMÉRIL, who died the 14th of Aug., 1860, aged 87 years, was born at Amiens, Jan. 1st, 1774. He had a taste for natural history and a peculiar ability for teaching it, which he exercised without cessation whether at the School of Science at Paris, where he taught zoology, or at the School of Medicine, where he was Professor of anatomy, or at the Museum where he taught herpetology, a speciality which he pursued with great success. His first publications, having for their object the natural classification of insects, bear the date of 1797. In 1800, he compiled, under the direction of Cuvier, the first two volumes of *Leçons Anatomie Comparée* of that great naturalist, who was pleased to acknowledge that he had not only aided him by his pen, but that he was in-

debted to him for many curious observations, among which was the analogy of structure existing between the vertebræ and the bones of the cranium. He may be considered as one of the founders of those anatomical theories which four years later exercised a powerful influence upon the direction of the studies of naturalists.

About the same time Duméril succeeded Cuvier as professor at the central school of the Pantheon, where he had for his colleague, Alexander Brongniart. In 1802, Lacépide entrusted to him, the course on herpetology and ichthyology at the Museum. He filled this appointment for 55 years; during this period he formed, at the Museum, the most beautiful collection of herpetology which exists, as well as a menagerie for reptiles, the first which had been undertaken. About this time he also published in connection with M. Bibron his valuable work on general herpetology.

Afterwards he was engaged upon his *Icthyologie Analytique;* he was then 80 years of age: still later he wrote his *Entomologie Analytique,* in two volumes. When he presented this work to the Academy of Sciences he was 87 years of age.

Like Duvernoy, his rival and fellow disciple,* he devoted as much as half of his time to the practice of medicine and in 1805 he is seen in Spain confronting the dangers of a malignant epidemic in order to contribute to the progress of his art: thus he never overlooked the practice of medicine, although as has been stated, he taught comparative anatomy. He occupied successively several different chairs in the faculty of Medicine at Paris.

M. Payer.—Jean Baptiste Payer, died September 5th, 1860. Born February 3d, 1818, at Asfeld, (in the Department of Ardennes,) he was at an early age distinguished for the splendor of his oratory. He entered upon the study of law and the sciences and was made doctor in 1840. In the same year he was appointed Professor of mineralogy and geology at the Faculty of Science of Rennes. He did not long retain this position which diverted him from his favorite pursuit of botany. He returned to Paris the following year to teach Botany at the Normal School, and to supply the place of M. de Mirbel at the Faculty of Sciences.

Although constantly occupied as incumbent of the chair of botany he fitted himself to receive the degree of Doctor of Medicine and Pharmacy in 1843, at the school of Pharmacy at Strasbourg. There are two other schools of Pharmacy in France, viz., at Paris and Montpellier, but that at Strasbourg is the most important in relation to the studies which are pursued there, and the care with which the students are exercised in the pursuits of chemistry and natural history. Payer passed there, the following year, his fourth examination, as did the chemist, Gerhardt, the next subsequent year, and sustained with great honor a thesis upon the natural system of botany.

In 1848, after the revolution of February, he was appointed Minister of Foreign Affairs, by M. de Lamartine, chief of the cabinet, and he was also a representative of the people in the Constituent Assembly, where he belonged to the democratic party. Despite these distractions, he did not lose sight of his plans for the future, for they were realized in 1852,

* See this Journal, [2,] vol. xx, p. 105.

when he was named for the chair of vegetable organography at the Faculty of Sciences of Paris, in place of Auguste de Saint-Hilaire.

This chair was soon united with that of Vegetable Anatomy and Physiology, which became vacant by the death of Adrian de Jussieu. It was about this time that Payer published his principal works on Natural History.

We are indebted to him for memoirs upon various questions in vegetable anatomy and physiology, but his most important labors were related to a new science called by M. de Mirbel, *Organogeny*. He developed the latter in a great work, entitled "*Traite d' Organogenie Végétale Comparée.*" He also published "*Botanique Cryptogamique ou Histoire des Familles Inférieures.*" He edited D'Adanson's "*Le Cours Elémentaire d'Histoire Naturelle,*" to which is added an introduction and notes on the natural families of plants by the same author. His treatise on organogeny made him the leader of a new school in which relation he is reproached for want of respect for his seniors: we have had occasion before to speak of this subject in this Journal, in 1857.

The death of Payer surprised every one, his friends not excepted, for they were unacquainted with his disease; he succumbed to the results of a surgical operation for a fistula; we shall presently allude to this again.

Pierre Daussy.—M. Daussy also succumbed to a surgical operation, which is usually devoid of danger, viz., lithotrity. Born at Paris in 1792, Pierre Daussy was admitted in 1806 to the corps of hydrographic engineers. After having, for fifteen years, taken part in the survey of the coast of France, he was nominated in 1829 as chief engineer of the French marine.

His memoir upon the perturbation of planets was in 1813, honored by the Academie des Sciences. Besides various articles furnished to the *Connaissance des Temps*, we are also indebted to him for a report upon the arc of the meridian between Dunkirk and the island of Formentara,* also for *Des Tables des Positions des Principaux Lieux du Globe*, 1847, *in* 4°, and a great number of other papers of much value.

Insalubrity of the air of Paris.—The operation, by no means severe, which cost M. Payer his life, has called attention to questions relating to the air of great cities. Dr. Castelnau reported in the *Moniteur des Sciences Médicales et Pharmaceutiques* that it had long been known to the surgeons of Paris, that surgical wounds do not unite as well in Paris as in the country. This may explain the numerous failures of Velpeau, chief surgeon of the Hospital La Charité. M. Castelnau declares that there is less danger to be apprehended from the operation of an empiric, than from an operation at Paris by the best surgeon. "Since this fact," says Dr. C., "is daily verified before our eyes, it is truly surprising that such an operation as M. Payer underwent, and which requires no haste, should be performed in the heart of Paris, when it is so easy to remove the patient to a healthy locality." Surgical operations performed at Paris, are frequently followed by erysipelas of a character more or less alarming, which appears to pass from one patient to another, as though carried by the clothes of the surgeon. Despite the ability of the operator, the Cæsarian section has never been successful at Paris. Amputations of the

* *Rapport sur la determination de la longueur de l'arc du méridien entre les parallèles de Dunkerque et I. Formentara.*

thigh are almost always fatal at Paris, though they generally terminate favorably, when performed upon the field of battle.

Diffusion of Germs, (Panspermia), ***Researches upon Spontaneous Generation.***—We recently gave our readers the views of this question entertained by Pouchet;* many scientific men have pronounced against the conclusions of this zoologist, and have referred the origin of the vegetable mycoderms obtained by him, where the atmospheric air was excluded, to microscopic germs floating in the air, and which are so small that they may be introduced into the apparatus, despite the precautions taken to exclude them. According to this theory it is necessary to suppose that the air is full of these germs, therefore Pouchet has undertaken to submit the atmospheric air to microscopic examination. He has not found either germs or spores of infusoria in the dust suspended in the air, but he has found a great number of grains of starch. The air of great cities and other inhabited places, contains many of these starch grains, which, according to him, one might take to be eggs of infusoria, or germs of mycoderms. He has found them among the dust of old cathedrals, and even in dust obtained from Egyptian mummies, and the chambers of the pyramids, as well as among the ruins of Grecian temples. Yet there must be something in the air which has escaped recognition by the microscope, for by causing a quantity of air to pass through a tube containing calcined asbestos, and introducing some of this material into liquids which previously had access only to calcined air, and which consequently contained no trace of vegetation, Pasteur has been able to develop mucedines. We have seen the apparatus of this chemist in use at the *École Normale de Paris*. This apparatus is remarkable for its simplicity and its precision, and it is impossible to object to his conclusions, for they preclude the possibility on the part of nature to continue her creative work in connection with elements purely mineral, or to animate them with the organic influence.

This chemist has already informed us,† that, in order that vegetation may be developed, or fermentation produced, there is required a liquid containing water, a salt having ammonia as a base, a carbonaceous substance, and a phosphate; the air is necessary only for the moment while we introduce into the flask, some spores of *penicilium*, or a little dust obtained from the air by the process indicated above. The mycodermic vegetation is then developed in less than a day, and, what is particularly remarkable, it is developed in the dark as well as in the light. The ordinary law does not govern these little organisms, for they neither give out oxygen nor absorb free carbonic acid; but on the contrary they disengage carbonic acid, and increase by fixing ammonia and phosphoric acid. The germs which produce these marvelous effects are not uniformly distributed in the air; thus Pasteur, making comparative experiments with one and the same liquid arranged in flasks completely deprived of air, found that the air from the cellars of the Observatory, contained only one-tenth part as many germs as the air from the court of that establishment; and

* See this Journal, [2,] xxvii, p. 253, and xxix, p. 414.
† See this Journal, [2,] xxix, p. 412.

that the air contained fewer germs in proportion to its elevation in the atmosphere. This chemist has performed comparative experiments in the mountains of Jura, at an altitude of 800 metres, and in the Alps at Montanvert, (Savoy), at 2000 metres above the level of the sea; and he has proposed to take the air from a much greater elevation by the aid of a balloon.

These researches present an interesting field to the naturalist. Pasteur has many species in vegetation, new and hitherto unknown. By varying the conditions, it will doubtless be possible to obtain others, as Paul Laurent has already done with the infusoria in a work of which we shall speak further on. On the occurrence of these researches, Boussingault called attention to a fact pointed out by Bineau, of Lyons, who, while examining a specimen of rainwater, containing nitrates and ammonia in solution, found these materials disappearing under the influence of cryptogamic vegetation. In reference to this great question of the assimilation of nitrogen, we would refer the reader, who wishes to understand it thoroughly, to the valuable work of Boussingault, just published, entitled, "*Agronomie, Chimie Agricole et Physiologie.*"

In order that plants may be developed in meteoric waters, these waters should be found in the condition of Pasteur's liquids. It is known that rainwater contains assimilable nitrogen and also salts of potash, soda, lime, &c., but it has heretofore lacked the indispensable element, phosphoric acid, which had never been detected in rainwater. This chasm in the series of fertilizing principles of meteoric waters, has at length been filled by Barral, who has discovered phosphates in rainwater. To avoid all sources of error, this chemist has experimented entirely with an apparatus of platinum. In the residue of evaporation he has obtained the phosphorus in the condition of phosphoric acid, as phosphate of bismuth, (Chancel's process), and as the ammoniaco-magnesian phosphate. He has thus found a quantity of phosphoric acid, varying from ·05 to ·09 of a milligram to a litre of rainwater (=0·000·5 to 0·000·9 gram).

From these results it may be calculated that the rainwater of an ordinary shower furnishes about 400 grams of phosphoric acid to the French *hectare* (or 2½ English acres). Now since the researches of Boussingault have proved that a hectolitre, (2¾ bushels), of wheat takes from the soil about one kilogram of phosphoric acid, we see that to obtain seven or eight hectolitres of wheat to the French *hectare*, which corresponds to a harvest without the use of manure, it would be necessary to let the field repose for twenty years, if the soil did not previously contain a trace of phosphates. Barral in 1850 to 1852, made researches upon rainwater to detect the presence of phosphoric acid in the residue of evaporation; the udometres and other vessels of platinum employed in the present investigations were constructed at the expense of the Academie des Sciences.

Chemical Synthesis.—The most remarkable scientific event of modern times, is the publication of a treatise on chemistry, proceeding on the same plan in organic chemistry, as has been adopted for a century past, in mineral chemistry, that is, forming organic substances *synthetically* by combining their elements by the aid of chemical forces only. The author who has performed his demonstrations by this method, is Berthelot, who has been occupied with organic synthesis since he first devoted himself to

chemistry. Berthelot is not a *vitalist*, (see our last contribution);* he is convinced that, "we may undertake to form *de novo*, all the substances which have been developed from the origin of things, and to form them under the same conditions, by virtue of the same laws and by means of the same forces which nature employs for their formation." Let us hasten to add a distinction upon which Berthelot properly insists and which it is necessary to recognize, between organs and the matter of which they are composed. "No chemist pretends to form in his laboratory, a leaf, a flower, a fruit or a muscle, these questions relate to physiology," and it was by not observing this distinction that it was possible to form that school of medicine of which mention was made in my last communication—and which referred everything to vital force. (See *Journal de Chimie et de Pharmacie*, Sept., 1860). This distinction being admitted and calling to mind the syntheses recently effected, such as the direct preparation of C^4H^4 from carbon and hydrogen, and alcohol from the union of C^4H^4 and water, we may understand the possibility of performing for organic chemistry what has been done for mineral chemistry, and to give to it a basis independent of the phenomena of life.

"I have taken for a point of departure, the simple bodies; carbon, hydrogen, oxygen and nitrogen, and I have constructed by combination of these elements, organic compounds, first binary then ternary, &c., the former analogous and the latter identical with the proximate principles contained in living beings themselves." Notice the progressive order of these synthetic formations. "The substances which we first prepare by methods purely chemical are the principal carbids of hydrogen, that is to say the fundamental binary compounds of organic chemistry. As a means of producing all the parts from the elements themselves, we take oxyd of carbon, that is to say a substance purely mineral, and by the concurrent influence of time and ordinary affinity, we combine this oxyd of carbon with the elements of water, (e. g., by the aid of pressure and the presence of an alkali); we thus obtain a first organic compound, known as formic acid. This acid united to a mineral base, produces a formate, then decomposing this formate by heat we compel the carbon of the oxyd of carbon and the hydrogen of the water to combine in the nascent state and produce carbid of hydrogen. Thus there is formed marsh gas, propylene, &c., &c. This is the first step of synthesis.

The hydrocarbons thus prepared become the starting point for the synthesis of alcohols; with marsh gas and oxygen we form methylic alcohol, with olefiant gas and water—ordinary alcohol, &c.

The synthetic production of carbids of hydrogen and of alcohols constitutes the true difficulty, but we know that even in this, Berthelot has triumphed.† The alcohols once obtained, it is easy to obtain the greater part of the other organic compounds by the ordinary chemical forces. This chemist has thus established the fact that organic chemistry reposes upon the same basis as mineral chemistry.

What has been said of the alcohols may also be said of various other classes of organic compounds, and among others of that new group, which Berthelot calls the *Phenols*, and to which he has devoted a very interest-

* This Journal, [2,] xxx, p. 412.
† See this Journal, [2,] xx, p. 111 and p. 265.

ing chapter. *Phenol*, or *carbolic acid*, $C^{12}H^{6}O^{2}$, the type of this group, may also be obtained by direct synthesis.

Starting from benzine, $C^{12}H^{6}$, it is transformed by nitric acid into $C^{12}H^{5}NO^{4}$ (nitro-benzine), which under the influence of nascent hydrogen, (the Zinin process) becomes $C^{12}H^{7}N$, (aniline), and this under the influence of nitrous acid is changed into phenol, $C^{12}H^{6}O^{2}$, as was shown by T. S. Hunt, in this Journal, [2,] viii, p. 372.

In Synthesis, or the forces of nature, substituted for hypothesis, we see the basis of the truly original work, now under notice. Berthelot is the youngest, but also the most distinguished of our chemists.* He owes his success to the cause which gave power to Laurent, Gerhardt and other savans of the first order, to the guiding power of a fundamental idea, which in the case of Gerhardt, was, *Series*, but in the case of Berthelot, is *Synthesis*. He is only 34 years of age, and yet his work, "*La Chemie Organique, fondée sur la Synthese*" gives promise to its author of a glorious future, and to science great progress and brilliant discoveries.

Acclimation.—We have before mentioned a project conceived by the Society for Zoölogical Acclimation, (*Societé Zoölogique d'Acclimatation*)† of forming a model garden for conducting the acclimation of useful plants or animals, and for cultivating an interest in this kind of enterprise. This garden was opened the 6th of October last, and immediately made available to the public; considerable sums of money have been subscribed to make it both a useful establishment and a work of art. Fifteen months have been sufficient for this purpose. The Garden is established in the forest of Boulogne; besides the necessary buildings for offices, it includes large stables, many and elegant rustic pavillions, designed for different species of animals, an immense aviary, a large enclosure for fowls, an elegant nursery for silkworms, an aquarium of unusual extent, greenhouses, and a winter garden not yet entirely completed. The other buildings are completed and already filled. A large stream, drawn from the Seine flows through the garden and forms a beautiful ornament; it is occupied by a great number of aquatic birds.

The collection of the Zoological Garden of Acclimation, (*Jardin Zoologique d'Acclimatation*), is composed of, 1st, species and races which they have tried to acclimate in France; 2nd, species and races whieh have been acclimated in other countries, or which are habitually reared either for use or pleasure. Already the Société Zoologique d'Acclimatátion extends throughout the entire world. We have recently mentioned the successful efforts of this society to introduce the dromedary into the desert plains of Brazil.

The Arch-Duke of Austria has sought instruction for making experiments of acclimation in the Isle of Crôma: also an Italian silk culturer favored by the relations of this Society, has succeeded in penetrating the silk districts of China, and has spent nearly two months near the city of Ouchau-fu, and has learned many of the processes employed in that country in the culture of the silk worm. It being impossible to reproduce here the interesting report which Castellani has addressed to the Society we refer the reader to the *Bulletin de la Société Zoologique*

* Biographisch-litterarisches Handworterbuch, par Poggendorff, 1858.

† See this Journal, [2], xxviii, p. 431.

d'Acclimatation, where he will find, besides this memoir, other reports, as that of Guérin Mannaville concerning the important subject of silk and the insects which produce it.

During the sojourn of Castellani in China he learned the important fact that in that country no species of silkworm is reared in the open air; for those worms which are not devoured by birds soon perish if they do not receive that intelligent care which the Chinese from time immemorial have learned to give them. The contrary has been long maintained, and it was upon a belief of such reports that they endeavored in France to rear the Bombyx Cynthia in the open air. The Bulletin de la Société d'Acclimatation contains many notices of almost complete success of experiments undertaken in the early part of the year 1859. The Bombyx Cynthia feeds upon the leaf of the *Aylanthus glandulosa.*

The Serimetre.—We cannot leave the subject of silk without mentioning the interesting machine invented by Froment for the purpose of determining *the relative tenacity and elasticity of different kinds of silk.* This instrument measures at once, 1st. The tenacity of a thread by the weight necessary to break it. 2d. The elasticity, by the elongation it sustains before breaking.

We cannot here describe this instrument, but we may give an idea of the precision of its action by stating that it enables us to determine the tenacity and elasticity of a spider's web.

These researches have led to very curious results, of which the following possess the most general interest.

1. The climate, food, and general care have a considerable influence upon the tenacity of silk, for example, the cocoons raised in Avignon gave a tenacity of 12, while cocoons of the same species raised at Paris gave only 8.

2d. It appears that the male cocoons furnish silk finer and more tenacious than that of the female cocoons. Thus for an equal length the weight of the male cocoons being represented by - - - 11·28

That of the female cocoons was - - - - - - 11·59

Again a mean of 200 experiments gave for male cocoons a tenacity of - - - - - - - - - - 10·63

For female cocoons the tenacity was - - - - - 9·80

By reason of the small difference between these numbers the results are for the present offered with some degree of doubt, but the Société d'Acclimatation has taken measures for removing these doubts. The *Sericometric* experiments, which we have mentioned, were made under the direction of Persoz, from whose report we have taken them.

Pseudomorphism and Pseudomorphosis.—Metamorphism, considered in the most general manner, comprehends all the modifications experienced by mineral substances; the subject may be divided according as it relates to minerals or to rocks. The first—the metamorphism of minerals—has been made, by A. Delesse the subject of profound study, which he has distinguished by the name of *pseudomorphism.* When a mineral is presented under a form which does not properly belong to it there is said to be pseudomorphism. The substance to which a mineral imparts its form may vary; it may even be of an organic nature, for a

mineralogist sees a case of pseudomorphism even in a bone, phosphate of lime is not there found in its usual form.* Delesse makes a distinction between the original or substance *pseudomorphosed*, and the *pseudomorphic* or mineral substance which replaced the first.

He also distinguishes between *pseudomorphism by alteration* and *pseudomorphism by displacement;* in the former the pseudomorphic mineral contains the elements of the first substance; in the latter the first substance has completely disappeared. For example, iron pyrites which changes into hydrous oxyd, preserving its form becomes pseudomorphic *by alteration*, while fluor spar which is replaced by quartz, is pseudomorphic *by displacement.*

Delesse arranges among pseudomorphs, the forms by *envelopment*, so well described in Prof. Dana's Mineralogy; also those phenomena which Naumann has called *zoomorphosis* and *phytomorphosis*, produced when organic matter is replaced by a mineral substance† or by other matter in a different condition.

Thus vivianite is sometimes developed in the interior of bones, in the shell of mollusks and in vegetables. Prof. Dana has seen it completely replace the calcareous beak of belemnites, and I myself have seen it developed in human bones buried in ferruginous soil; a part of this phosphate had even crystallized in the form of vivianite (see this Journal, [2], xxi, p. 402), even coal sometimes pseudomorphs certain fishes into cupriferous and bituminous slates (as those of Mansfeld.)

The simple bodies are rarely pseudomorphic; they are more frequently pseudomorphosed; for the most part there is no relation between the composition and form of pseudomorphosed bodies and pseudomorphic bodies, so also the composition of bodies appears to be without influence upon forms by envelopment.

Pseudomorphism by alteration is more frequent than pseudomorphism by displacement, inasmuch as the mineral newly formed more frequently depends upon the more ancient. The same mineral may be pseudomorphic or pseudomorphosed, without the existence of any rule in this respect, this condition is often presented by such minerals as quartz, carbonate of lime and pyrites as they occur in nature. Delesse has found among 105 pseudomorphic minerals and 119 pseudomorphosed minerals, or 224 in all, only 60 minerals that are both pseudomorphosed and pseu-

* Grasses and lichens belong to this class; the first owe their structure to silica, the others to oxalate of lime. A parallel generalization is evidently an exaggeration; these organic forms have been produced under the influence of life, and according to an invariable type, very unlike those pseudomorphs or forms obtained by epigenesis.

† To us the Saurian does not appear more different from a bird than the paramorphic bodies arranged in this category of Delesse. Laurent is the author of paramorphism, who defined it as follows: "I place in this class those bodies which have a different composition and which are isomorphic but in different systems," thus octohedric AsO_3 is paramorphic with prismatic SbO_3, and prismatic AsO_3 is paramorphic with octohedric SbO_3, &c.—(*Laurent, Méthode de Chemie,* 1854, p. 172.)

It is much to be regretted that Delesse was not acquainted with the researches of Prof. Cooke on allomerism (see this Journal [2], xxx, p. 194, and *Journal de Chemie et Pharmacie,* t. xxxviii, p. 383). The ideas of Prof. Cooke explain very well the difficulties met with by Delesse and other mineralogists. J. N.

domorphic. Now admitting that the total number of minerals known is 642, the proportion of minerals in which pseudomorphism is found reaches one-fourth this number.

In this connection we may remark that these minerals are found for the most part in the metalliferous rocks.

The question of Inundations.—This important question, which has always been studied in France, has made considerable progress—a new cause of inundations has been discovered. The author of this discovery is an engineer, M. Gueymard of Grenoble, who has studied the Alps for nearly 50 years. In his opinion this cause is the absence of grass upon the sides of mountains. It existed at the commencement of this century but it has been destroyed by the great numbers of sheep pastured upon the mountains. Where grass was found fifty years ago the slopes are now denuded, and incapable of retaining the waters which have fallen in rain. Wherever there is a surface of sod 10 centimetres thick, for example, containing 10 per cent of water, it will absorb a layer of water 4·75 centimetres deep. Gueymard has concluded that the inundation which on the 30th of May, 1856, overflowed the valley of the Isère would have caused no damage if the slopes of the mountains had presented to the torrent of rain a covering of grass 20 centimetres in thickness, the earth would then have absorbed a layer of water 9·5 centimetres deep and the evil would have been averted.

The principal remedy for inundations is therefore to be found in *turfing*. Gueymard estimates ten years as the time necessary to produce upon the flanes of mountains a sod of sufficient consistence to resist effectually long continued rains.

He does not believe that destroying the forests upon mountains is the principal cause of inundations. He bases his opinion upon the fact that although there were no inundations in France from 1793 to 1840, the period during which the forests destroyed during the Revolution and restocked at the commencement of this century had not attained their full growth, yet the disasters of 1840 commenced when the forests had attained their full strength. But from 1800 to 1840, the flocks of sheep were increased three-fold, and in proportion as the trees increased in size the grass disappeared under the teeth of the animals, and with it the most efficient protection against inundations.

The French government has taken these observations under serious consideration, and made them the subject of careful study.

Bibliography.

BOSSANGE, *Paris*, has recently published:

Zoologie du Jeune Age, par Docteur LEREBOULLET, Professor de Zoologie à la Faculté des Sciences de Strasbourg.—This is a beautiful volume in quarto with colored figures. Professor Lereboullet is one of the most distinguished Zoologists in France. A considerable part of this work is elementary and in the form of lectures.

La Chimie Organique fondée sur la Synthese, par MARCELLIN BERTHOLLET, 2 vols. in 8vo, 1860. [This work is noticed above, p. 270.]

Les Electro-animants et l'adhérence Magnetique, par J. NICKLÈS.—This is a work almost entirely new, and full of facts not before published, (see this Journal [2], xxx, p. 413).

Notions de Physique, par POUILLET, 3d edition in 12mo.—This is a very excellent elementary work for those who are commencing the study of Physics.

Das Buch der Natur, par DR. FDK. SCHOEDLER, 11th edition, 2 vols. 8vo.—This is a work of the same class as the preceding but much more complete, for it embraces not only physics, but physical geography, astronomy and chemistry. The first edition appeared in 1844, and was received with such favor that it has passed through eleven editions in sixteen years.

Etudes Physiologiques sur les Animalcules des Infusoires Végétales, par PAUL LAURENT, Professor a l'Ecole Forestière de Nancy. 2 vols. in 4to with numerous illustrations. This work has acquired much importance from the recent discussions upon spontaneous generation. M. Laurent has given the results of 25 years of observation. The first volume is entirely devoted to infusoria, the second volume treats especially of the elementary organs of vegetables.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a Compound of Boron with Ethyl.*—FRANKLAND and DUPPA have succeeded in forming a combination of ethyl and boron by the action of zinc-ethyl upon boric ether. The reaction is represented by the equation

$$2(BO_3 . 3C_4H_5O) + 3Zn_2(C_4H_5)_2 = 2B(C_4H_5)_3 + 6C_4H_5O, ZnO.$$

and is particularly interesting as offering a new method of forming compounds of the elements with compound radicals. When zinc-ethyl is brought in contact with tribasic boric ether the temperature rises gradually during half an hour. On submitting the liquid to distillation a colorless liquid passes over between 94° and 120°. The distillation is then to be interrupted. The remainder in the retort solidifies to a crystalline mass, which is a combination of ethylate of zinc and zinc-ethyl. The distillate after two rectifications, boils between 95° and 97°. It then corresponds to the formula $B\left\{\begin{array}{l}C_4H_5\\C_4H_5\\C_4H_5\end{array}\right.$. Borethyl is a colorless soluble liquid which has a sharp odor: its vapors strongly irritate the mucous membranes and provoke a flow of tears. Its density is 0·6961 at 23°: it boils at 95°; the density of its vapor is 3·4006. The theoretical vapor-density, calculated according to the condensation of chlorid of boron, would be 3·3824.

Borethyl is not easily decomposed by water, in which it is insoluble. The liquid itself takes fire spontaneously in contact with the air and burns with a magnificent green and smoky flame; in contact with pure oxygen it explodes. When submitted to slow oxydation it forms a colorless liquid boiling at higher temperature than borethyl, but which cannot be distilled at ordinary pressures. By distillation in vacuo, this liquid may be obtained pure, and its constitution is then expressed by the formula

$$B\left\{\begin{array}{l}C_4H_5\\C_4H_5O_2\\C_4H_5O_2\end{array}\right..$$

This compound dissolves immediately in water, decomposing into alcohol and a white crystalline substance which may be sublimed without alteration in a current of carbonic acid gas. It then forms magnificent

scales like those of naphthaline. Its constitution is represented by the formula $B\left\{\begin{matrix}C_4H_5\\HO_2\\HO_2\end{matrix}\right.$, and its formation depends evidently on the substitution of two atoms of hydrogen for two atoms of ethyl in the compound $B\left\{\begin{matrix}C_4H_5\\C_4H_5O_2\\C_4H_5O_2\end{matrix}\right.$. This substance possesses an agreeable ethereal odor, and a very intense sweet taste. When exposed to the air, it volatilizes slowly at ordinary temperatures, and is partially decomposed, always leaving a little boric acid. Its vapor possesses an intense sugary odor; it reddens litmus paper, although its other acid properties are but feeble. Water, alcohol and ether easily dissolve it; it melts at a gentle heat, and boils at a high temperature, with partial decomposition.

The authors promise an extended study of these substances as well as of the reactions of zinc-ethyl with silicic, carbonic and oxalic ethers.—*Ann. de Chimie et de Physique*, lx, 374, November, 1860. W. G.

2. *On the vapor-density of Chlorous Acid.*—The vapor-density of chlorous acid was found by Millon to be 2·646. This corresponds to a condensation from 5 volumes to 3; the calculated vapor-density is then 2·7454. According to this determination, chlorous acid forms a remarkable exception to the law now generally assumed that all substances in the state of vapor correspond to 2 volumes; it also renders it necessary to consider the atomic weight of oxygen 8, and not 16.

Schiel has therefore undertaken a new determination of the vapor-density of the acid, and finds in two experiments the numbers 2·723, and 2·603, which corresponds closely to the determination of Millon. The author proposes to control these determinations by observing the ratio of the volumes of chlorine and oxygen which are obtained from a known volume of the acid.—*Ann. der Chimie and Pharm.*, lxvi, p. 115.

W. G.

3. *New Researches on the Oxyd of Ethylene.*—Wurtz has communicated some exceedingly interesting and important results of his continued investigations of the ethylene series. These may be briefly stated as follows: 1. Oxyd of ethylene unites directly with acids and neutralizes them. When the oxyd is heated in a water-bath with concentrated chlorhydric acid, the two unite directly forming chlorhydrate of oxyd of ethylene. The oxyd unites in like manner with anhydrous or hydrous acetic acid, and gives among other products the neutral acetate. 2. In uniting with acids the oxyd of ethylene is capable of forming basic salts. Thus in the last experiment, after separating the neutral acetate by distillation, there remains a considerable quantity of a liquid boiling above 200°.

This contains three products which may be considered as basic acetates of oxyd of ethylene, and which constitute in reality the acetates of polyethylenic alcohols. The first boils at about 200°, and constitutes diethylenic acetate, which is formed in consequence of the following reaction:

$$2(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,\ 2C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_6.$$

When saponified by baryta, this acetate is resolved into acetic acid and diethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_2\\H_2\end{matrix}\right\}O_6$

The second product boils toward 290°, and constitutes triethylenic acetate.

$$3(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,3C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

Under the influence of baryta it yields acetate of baryta and tri-ethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_3\\H_2\end{matrix}\right\}O_8$. Finally, the third product boils above 200°, and when distilled in vacuo is a thick colorless liquid, tetrethylenic acetate.

$$4(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,4C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_{10}.$$

Baryta transforms this into acetate of baryta and tetrethylenic alcohol. This last is a thick colorless neutral liquid, soluble in water and boiling above 300°.

Oxyd of ethylene is also capable of combining with diacetic glycol to form polyethelenic acetates.

$$C_4H_4O_2+\left.\begin{matrix}C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_4=\left.\begin{matrix}C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_6.$$

This reaction is comparable with that which transforms acetate of lead into basic acetate, when the neutral salt is brought into contact with an excess of oxyd of lead.

$$2(Pb_2O_2)+\left.\begin{matrix}\overset{\prime\prime}{Pb}\\(C_4H_3O_2)_2\end{matrix}\right\}O_2=\left.\begin{matrix}\overset{\prime\prime}{Pb}_3\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

The basic properties of oxyd of ethylene are especially shown in the action which it exerts upon saline solutions. When the oxyd is mixed with a concentrated solution of chlorid of magnesium, the liquid after some hours solidifies; magnesia is precipitated, while chlorhydrate of oxyd of ethylene is formed.

The oxyd on the contrary is displaced by potash, when this is made to act upon the chlorhydrate. Heated upon a water-bath with a solution of perchlorid of iron, the oxyd of ethylene precipitates the hydrate of the sesquioxyd: it also precipitates alumina from a solution of alum and subsulphate of copper from a solution of the sulphate. These facts exhibit clearly the basic properties of oxyd of ethylene, which is comparable with the anhydrous oxyd of zinc, or oxyd of lead, while glycol itself corresponds to the hydrates of these oxyds.

$$\left.\begin{matrix}\overset{\prime\prime}{Zn}\\H_2\end{matrix}\right\}O_4,\quad\left.\begin{matrix}\overset{\prime\prime}{Pb}\\H_2\end{matrix}\right\}O_4,\quad\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_4.$$

—*Repertoire de Chimie Pure, Sept.* 1860, p. 340. W. G.

4. *Transformation of Olefiant Gas into complex Organic Acids.*—In his memoir on the glycols, Wurtz had expressed the opinion that these might

be considered as the alcohols of diatomic acids: the following facts serve to confirm this view. By oxydizing diethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6$ he has obtained an acid isomeric with malic acid, and under the same circumstances, has transformed triethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8$ into a still more complex acid.

The oxydation of diethylenic alcohol is easily affected by nitric acid which acts very violently; the acid liquid crystallizes when evaporated. The liquid is to be saturated with milk of lime, when a small quantity of oxalate of lime separates. The filtrate yields a lime salt in long and brilliant needles, which has the formula $C_8H_4Ca_2O_{10}+12HO$.

The acid is most easily prepared by decomposing the silver salt with sulphydric acid gas; the solution deposits voluminous crystal after concentration. The new acid crystallizes in large rhomboidal prisms, possessing a distinct acid-taste. It is very soluble in water or alcohol; its composition is expressed by the formula $C_8H_6O_{10}+2HO$.

When distilled, it yields a thick liquid which crystallizes after some time, and which constitutes a true pyrogenic acid. When fused with hydrate of potash, hydrogen is given off, while acetic and oxalic acids are formed. Wurtz considers it probable that this acid is identical or isomeric with an acid obtained by Heintz as an accessory product in the preparation of glycolic acid, by means of monochloracetic acid and hydrate of soda.

In the oxydation of triethylenic alcohol two acids are obtained, one of which is identical with that just described; the other has the formula $C_{12}H_{10}O_{12}$. This acid does not crystallize, but after separation remains in the form of a syrupy mass.

The author remarks that in the oxydation of the polyethylenic alcohols a certain quantity of hydrogen disappears and is replaced by an equivalent quantity of oxygen. We may admit that the two acids just described are derived from two corresponding alcohols, just as glycolic acid is derived from ethylenic alcohol, by the transformation of a certain number of molecules of ethylene, C_4H_4, into glycolyl, $C_4H_2O_2$, as the following formulas show.

$\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_4.$	$\left.\begin{matrix}C_4H_2O_2\\H_2\end{matrix}\right\}O_4.$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6.$	$\left.\begin{matrix}C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_6.$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8.$	$\left.\begin{matrix}C_4H_4O_2\\C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_8.$
Glycol.	Glycolic acid.	Diethylenic alcohol.	Diglycolic acid.	Triethylenic alcohol.	Dyglycol-ethylenic acid.

These acids possess the molecular composition and the characters of the vegetable acids; they are obtained synthetically from olefiant gas, which is successively transformed into bromide of ethylene, glycol, oxyd of ethylene, polyethylenic alcohols, and finally into diglycolic and diglycolethylenic acids.—*Rep. de Chimie, Pure, Sept.* 1860, p. 342 W. G.

5. *On the determination of Phosphoric Acid.*—The process of CHANCEL for the determination of phosphoric acid by means of the acid nitrate of bismuth, has already been described in this Journal (vol. xxx, 122). The author now gives further details which are necessary to ensure the success

of the method, especially when iron is present. In this case, the precipitated phosphate of bismuth always contains iron, unless this metal is present in the form of protoxyd. The process to be pursued in general is as follows: 1. Treat the weighed substance with an excess of concentrated nitric acid by the aid of heat, so as to transform, if necessary, metaphosphoric or pyrophosphoric acids into tribasic phosphoric acid; redissolve by a sufficient quantity of nitric acid, add water, and filter if necessary. 2. Remove the sulphuric acid from the dilute solution by nitrate of baryta, then the chlorine by nitrate of silver. 3. Pass a current of sulphuretted hydrogen to saturation through the filtered liquid. In this manner the iron is completely reduced to protoxyd, even when the liquid contains a large quantity of free nitric acid, while silver and other metals which give insoluble sulphides are completely precipitated. Before filtering, the sulphydric acid gas must be completely removed by passing a current of carbonic acid through the liquid, till the gas no longer darkens paper soaked in acetate of lead. 4. An excess of acid nitrate of bismuth is then to be added to the filtered liquid, the precipitate allowed to settle, collected on a filter, washed with boiling water, dried, ignited and weighed. 5. The bismuth may then be removed from the filtrate by means of sulphuretted hydrogen, and the bases present determined in the ordinary manner.—*Comptes Rendus*, li, 882. W. G.

[See on p. 281 an interesting note on this subject by Mr. McCurdy.]

6. *On the preparation of Oxygen.*—H. St. Clair Deville and Debray, in studying the economical production of oxygen upon the large scale, have arrived at results which promise to be of great practical importance. The authors find that sulphate of zinc when heated alone in an earthen or porcelain vessel yields a light and white oxyd which may be utilized in painting; sulphurous acid, which is easily absorbed by water; and finally pure oxygen. The temperature required is not much higher than that which is necessary for the decomposition of peroxyd of manganese.

Another and very elegant process, consists in the decomposition of sulphuric acid by heat. A fine stream of the acid is allowed to flow into a retort of about five litres capacity, filled with thin platinum foil and heated to redness. The acid is completely decomposed into oxygen, water and sulphurous acid, which last is absorbed by an appropriate washing apparatus. The sulphurous acid may again be converted into sulphuric acid, in the usual manner.—*Comptes Rendus*, li, 822. W. G.

7. *On the Polyethylenic Alcohols.*—Lourenço has studied the action of bromid of ethylene upon glycol, and has discovered several new polyethylenic alcohols closely related to those already described by Wurtz. The diethylenic, triethylenic and tetrethylenic alcohols of Wurtz are among the products of the reaction and may be separated by a fractional distillation. In addition to these, the two alcohols belonging to the same series are formed. Pentethylenic alcohol whose formula is

$$\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_{12} = C_{20}H_{22}O_{12}.$$

is a viscid liquid like glycerine, soluble in water, alcohol and ether, and boils at about 281° under a pressure of $0{\cdot}025^{mm}$, that is to say almost in vacuo.

Hexethylenic alcohol is only to be distinguished from the last by its greater viscidity. It boils at about 325° under the same pressure of 0·025mm. Its formula is

$$\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_{14}=C_{24}H_{26}O_{14}.$$

When the operation is conducted for a sufficiently long time and an excess or glycol is employed, other alcohols of the same series are obtained, the general formula being $\left.\begin{matrix} nC_4H_4 \\ H_2 \end{matrix}\right\} O_{2n+2}$.

The compounds become more and more viscid as their molecular complication increases. We remark a difference of about 45° in their boiling points. When the mixture of bromid of ethylene and glycol is heated above 130°, very different results are obtained. The liquid becomes brown and the alcohols disappear, giving rise to the corresponding bromhydric ethers.—*Comptes Rendus*, li, p. 365. W. G.

7. *On Baudrimont's Protosulphid of Carbon.*—Playfair has examined the different processes given by Baudrimont, for the preparation of the protosulphid of carbon. These processes are not less than five in number; though the author admits that only the first yields the compound in a state of tolerable purity. This process consists in passing the vapor of bisulphid of carbon over red hot pumice stone or spongy platinum, by which, according to Baudrimont, sulphur is deposited and the gaseous protosulphid set free. Playfair found on repeating this process that no protosulphid of carbon whatever is formed, but that the gas given off consists of carbonic oxyd and nitrogen; while the greater proportion of the bisulphid of carbon passes over undecomposed. In like manner it was found that when the vapors of bisulphid of carbon were passed over red hot charcoal, only a mixture of carbonic oxyd, nitrogen and bisulphid of carbon was obtained. The author concludes that there is no sufficient evidence of the existence of protosulphid of carbon, all the processes described for its preparation, having failed to yield it.

W. G.

Analytical Chemistry.

Contributions from the Laboratory of the Yale Scientific School;—communicated by Profs. Brush *and* Johnson.

8. *Observations on Chancel's method of estimating phosphoric acid;* by Henry I. McCurdy.—The following new method for the detection and quantitative separation of phosphoric acid by means of nitrate of bismuth has been lately recommended by Chancel as of universal applicability. A nitric acid solution of the substance containing phosphoric acid is treated with a solution of nitrate of bismuth* as long as a precipitate is formed.

* Best prepared, according to Chancel's latest advice, by dissolving 68·45 gms. of the pure crystallized neutral nitrate of bismuth, $BiO_3\,3NO_5+10aq$ in a quantity of nitric acid representing 68·5 gms. of anhydrous nitric acid and bringing the solution to the volume of a liter. Each cubic centimeter of this solution precipitates 1 centigram of phosphoric acid.

It is then boiled, filtered and the precipitated phosphate of bismuth is washed with hot water, dried, ignited and weighed. Chlorine and sulphuric acid, if present, must first be removed by means of the nitrates of baryta and silver. Too great an amount of nitric acid must be avoided, since the phosphate of bismuth though insoluble in a moderate quantity of nitric acid, is soluble in a large excess.

I have recently made some experiments on this method, at the suggestion of Prof. Johnson, which go to show that in the presence of certain sesquioxyds it is utterly valueless. I proceeded as follows: a solution of nitrate of bismuth was prepared according to Chancel's directions, and also a solution of pure phosphate of soda. These two solutions were of such strength that one cubic centimeter of the nitrate of bismuth solution contained a little more bismuth than was necessary to precipitate the whole of the phosphoric acid in 1 c. c. of the phosphate of soda solution.

A strong solution of the nitrate of the sesquioxyd of iron was then prepared, and to 1 c. c. of it were added successively 1 c. c. of the phosphate of soda solution and 1 c. c. of the nitrate of bismuth solution. No precipitate was formed even after boiling the mixture. The pernitrate of iron was diluted with nine parts by volume of water, and to 1 c. c. of this dilute solution were added equal amounts of phosphate of soda and nitrate of bismuth. A rather bulky precipitate came down, but after boiling, the filtrate on being tested with molybdate of ammonia was found to contain phosphoric acid in large quantity. The experiment was repeated, using two, three and four c. c. of the dilute solution of ferric nitrate to 1 c. c. each, of the solution of phosphate of soda and nitrate of bismuth with similar results—the precipitate of phosphate of bismuth diminishing and the amount of phosphoric acid in the filtrate increasing regularly as more and more of the iron salt was added. When 5 c. c. of the solution of iron were employed to 1 c. c. each, of the two other solutions, there was no precipitate whatever, the whole of the phosphate of bismuth being held in solution by the nitrate of iron.

In all cases where phosphate of bismuth was precipitated in presence of nitrate of sesquioxyd of iron it carried down with it a notable quantity of iron, as manifested by the color of the precipitate, which was brownish red when a large proportion of iron existed in the solution and of a yellow tint when the amount of iron was small.

A strong solution of nitrate of alumina was prepared by saturating nitric acid (of sp. gr. 1·16) with pure, freshly precipitated hydrate of alumina, and some experiments were made with this solution, using in each case, 1 c. c. of the solution of phosphate of soda and 1 c. c. of the solution of nitrate of bismuth, to successively increasing quantities of the nitrate of alumina. With 1 c. c. of the nitrate of alumina solution there was formed a considerable precipitate, but when the solution was filtered, and tested with molybdate of ammonia it was found still to contain phosphoric acid. After dissolving this precipitate in hot nitric acid and separating the bismuth by sulphuretted hydrogen, ammonia indicated the presence of phosphate of alumina, showing that the phosphate of bismuth had carried down a portion of alumina with it. With 2 c. c. of nitrate of alumina there was scarcely any precipitate on boiling, and with 3 c. c. the phosphate of bismuth was entirely prevented from separating.

Experiments were made with a solution of nitrate of sesquioxyd of chromium and it was found that 5 c. c. of chromic nitrate employed to 1 c. c. each, of the solutions of phosphate of soda and nitrate of bismuth, were sufficient to prevent the formation of any precipitate. The solution used was a rather strong one.

Nitrate of sesquioxyd of uranium even in small quantities prevents the complete precipitation of phosphoric acid by this method, and when in large amount, dissolves the precipitate entirely. The phosphate of bismuth when thrown down from a solution containing uranic nitrate is contaminated with the latter.

A similar series of experiments was made with the nitrates of ammonia, potassa, baryta, strontia, lime, and magnesia. The presence of these bases does not seem to interfere with the success of the method.

It follows from these trials that the method proposed by Chancel, can not be applied in the presence of sesquioxyds of iron, aluminum, chromium or uranium, since, on the one hand the nitrates of these substances when in excess, have the property of dissolving phosphate of bismuth and thus preventing its precipitation, and on the other, when phosphoric acid is in excess, phosphates of these bases are thrown down in conjunction with the phosphate of bismuth.

Note.—Since these experiments by Mr. McCurdy were completed, we have learned from the *Comptes Rendus* that Chancel has discovered the inapplicability of his original method in presence of peroxyd of iron, and proposes to overcome this difficulty by reduction of the peroxyd to protoxyd. The details of the modified process are given on page 279. Chancel, however, still appears to overlook the fact that his process is, and is likely to remain valueless in just those cases where a new method would be most acceptable, viz. for the estimation of phosphoric acid in presence of alumina. S. W. J.

Yale Scientific School, Feb. 15, 1861.

TECHNICAL PHYSICS.

9. *On the loss of Light by Glass Shades.*—(To the Editor of Silliman's American Journal of Science and Arts)—*Sir:* In the November number of your Journal I find a notice of my experiments on the loss of light by glass shades, with an account of additional investigations by Mr. Frank H. Storer; his communication induces me to offer some further remarks on the subject.

The experiments were intended to be of a practical nature, and were tried solely in order to ascertain, (as I state in my letter to the London Journal of Gas Lighting), the loss of light occasioned by the use of the ordinary glass shades. It is not therefore quite correct for Mr. Storer to compare results obtained by the use of *flat sheets*, with the loss of light occasioned by *spherical shades.* He is right however in supposing that by "the loss of light," I intended to express "the actual diminution of the amount of light, falling for example, upon the pages of a book held near to its source, which would be occasioned by the interposition of the shades enumerated."

Prof. Verver had another object in view, and his experiments do not apply to this subject. *He* was investigating the illuminating power of gas when burnt in an Argand burner with, and without, a chimney. The

gas in these two cases is burnt under very different conditions, while in Mr. Storer's experiments, and those which I have tried, the gas was burnt under precisely the same circumstances whether a shade was interposed or not, the only difference being in the substances through which the light was transmitted.

I conducted my experiments in the following manner:—In order to avoid the trouble and inaccuracy arising from the use of a candle, I employed a gas-light as the standard of comparison throughout the trials of all the shades. This could easily be done, as in the blackened experiment chamber of the Liverpool United Gas Light Co., there is a duplicate set of apparatus, two governors, metres, burners, &c., being fixed at opposite sides of the room.

The lights, (which we may call A and B), having been made equal and their respective consumptions noticed, the first shade, (that of clear glass), was placed surrounding A, and the photometer screen moved towards it, until both sides of the screen were equally illuminated, the reading on the photometer staff was then found to be 1·118 on that side of the centre of the staff nearest A, or, in other words, the proportion of light given by B, (without a shade), was to the light given by A, (with a shade), as 1 to $\frac{1}{1 \cdot 118}$ or as 1 to 0·8944, or the loss of light by the use of the shade was equal to 10·56 per cent. The first shade was then removed, and the next substituted, and so on till the loss of light in each case was determined.

After all the shades had been examined, the lights were again compared, and found to be equal as at first adjusted. The quality of the gas and the descriptions of burner employed do not affect the question, provided that the same burner is used throughout all the experiments. The burners I used were "No. 3, Fish-tails," consuming 3·7 cubic feet per hour. The gas was taken from the street mains.

By using a standard light of unvarying intensity, all the errors likely to arise from inequalities in the consumption of a candle are avoided, and much time is saved in making the experiments as one or two observations with the photometer in each case are quite sufficient to ensure accuracy.

The divisions on the photometer staff do not necessarily represent candles, but the proportion that one light under examination, bears to the other, when one of them is taken as unity.

I may observe that the single experiment made with a *sheet* of common window glass was tried simply to confirm the result obtained by the globe of clear glass.

The distance at which the glass is placed from the light does not seem in the slightest degree to affect the amount of light transmitted through it. I am glad to find that my own experiments on this point are so entirely confirmed by Mr. Storer's statement. William King.

Liverpool United Gas Light Co., Dec. 28, 1860.

Note by Mr. Storer.

In reply to the courteous letter of Mr. King, I must express my regret that he has not more explicitly stated the reasons which lead him to object to a comparison of results obtained by the use of flat sheets of glass with those obtained when spherical shades are employed. That the light which is reflected back from the interior

surface of one side of a lamp-shade, of any form, would be compensated for by that similarly reflected from the opposite side—and that no similar compensation could occur in my own experiments where only single sheets of glass were used,—is evident; but I am ignorant of any experiments which go to show that the amount of light which is cut off from a given surface by the interposition of a *flat* screen is different from that which would be stopped by a *curved* screen *of the same material.* Let us suppose a precise example; in a large sheet of blackened tin we cut out an aperture, say of three or four inches diameter, and cement therein a flat sheet of ground glass and, having interposed the apparatus between a flame and the photometer, determine how much light is cut off by the glass, *i. e.*, bring the photometer to rest, as it were:—if now, having done this, we remove the flat sheet of glass and fasten in its place a segment of a lamp-shade of a material identically similar with that of the flat sheet first used, shall we find that our photometer is no longer in equilibrium? The same amount of light must have in each instance passed into the aperture in the sheet of tin;—why should it not be transmitted to our photometer in the same way in either case? The experiment cited would probably be difficult to carry out in practice since it would not be easy to find curved and flat screens of ground glass of precisely the same material, or ground equally rough. I state it merely in order that the conditions of the problem may be clearly understood, and with the desire that some proof may be given that the transmitted light would be less in one case than in the other,—a supposition not in accordance with received theories (see Art. Light in Encyclopædia Metropolitana, p. 347, §§ 42, 43); nor would it be inferred from what is known of the analogous case of radiant heat, (see LAMÉ, *Cours de Physique de l'Ecole Polytechnique*, 2 e Edit. Paris, 1840, i, 309).

On the other hand, looking at the question in its practical bearing, it is clear that all lamp shades are not spherical. Witness, for example, the flat sheets of colored or ground glass used by the cars upon our street railways, the flat sheets of plain glass of the street gas lanterns, and the flat sheets of ground, enameled, or colored glass in the out-of-door lanterns of eating houses, &c.; to say nothing of the shades constructed of flat porcelain transparencies which are so commonly employed in this country to soften the glare of gas-lights; or of the lanterns of colored and enameled glass which were so often exhibited in the torch light processions of the Presidential campaign of the Autumn of 1860, and by which the phenomenon, of "loss of light by glass shades," now under discussion was so strikingly exhibited. In instituting a new series of observations, I therefore chose to make experiments, the results of which might be added to those of Mr. King, rather than to repeat the work which he had already so faithfully performed. In publishing my results, I regarded them as being merely supplementary to those of Mr. King, neither intending to institute any comparison between the two series of observations, nor directly to compare his spherical shades with my flat sheets. I intended to state only that my own experiments corroborated those of Mr. King in so far as they went to prove the *great loss of light* occasioned by the use of glass screens.

As for the experiment of Prof. Verver, to which Mr. King takes exception, he must pardon me, if I persist in maintaining that the observation does apply to the question at hand. It matters little in science, at any time, what *object* an experimenter may have in view, so long as the truth is attained and exhibited by his researches; but in the case in point, Verver's experiment, so far as it goes, applies directly to our subject. (See his own words, this Journal, Nov., 1860, [2,] xxx, 421.) Since, as I remarked in my previous note, the gas was indeed burned under somewhat different conditions in the two stages of Verver's experiment, his result must consequently be regarded as merely approximative; but before seeking to discard it altogether, Mr. King should have remembered that a globular glass shade surrounding a fish-tail burner is in some measure a *chimney*, and that therefore his own results cannot well be *entirely* exempt from the same source of error which affects the experiment of Verver. In making this remark, I would not in the least degree imply that Mr. King's observations are not most excellent. For my own part, I entertain no doubt of their accuracy;—for, throwing out the conceivable slight error to which I have alluded, his method of experimenting is unquestionably the best which is yet known. I urge only that the observation of Verver, must not be rejected.

FRANK H. STORER.

Boston, Feb. 6, 1861.

TECHNICAL CHEMISTRY.

10. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (From the Memoirs of the American Academy, [N. S.,] vol. viii, p. 27),* Cambridge, 1860, pp. 32, 4to.

In the words of the author:—"This research was undertaken in order to ascertain what, if any, definite chemical compounds could be detected among the alloys of copper and zinc."

"Several chemists had already been led to believe in the existence of two or more definite alloys, and at the commencement of my own labors I was strongly inclined to accept this view. A more extended investigation, however, has convinced me that no such definite compounds exist. On the contrary I am confident that all the alloys of copper and zinc are simply isomorphous mixtures of the two metals, capable, as I shall proceed to show, of crystallizing at any point, from copper with only a trace of zinc down to alloys containing but thirty per cent of copper, or even less, under favorable circumstances." "The misconceptions of previous observers† have evidently arisen either from a great tendency to separate into layers, instead of immediately forming a homogeneous mixture, which the metals exhibit when fused together, or from certain striking peculiarities of structure and of superficial coloration which occur among the d fferent alloys."

Mr. Storer has prepared a large number of alloys of copper and zinc containing different proportions of these ingredients, by methods which he has described in detail, and has found that they may all be crystallized by piercing the crust which forms upon the partially cooled molten metal and then quickly pouring off those portions of the latter which are still fluid from the crystals which have formed upon the walls of the crucible,—as in the common class experiment of crystallizing sulphur by fusion. At least he has succeeded in obtaining crystals from all the alloys which contain more than thirty per cent of copper. He has found it difficult, however, to crystallize any of the alloys which contain less than this proportion of copper since they are liable to pass through a pasty plastic state similar to that assumed by zinc or soft-solder while solidifying.

"These crystals are all octahedral, usually somewhat elongated and apparently much modified by the circumstances in which they have been formed. The edges of all of them are rounded. The octahedra are in general more largely developed upon one side than the other, apparently upon the side from which the last drippings of the melted metal fell. They are, moreover, combined together with parallel axes, which give to the crystals‡ a striated appearance; these striæ are not sharply defined,

* Communicated to the Academy, Nov. 9, 1859.

† "I must in this connection refer to and except, the valuable memoir of Karsten (*vid.* Karsten u. Dechen's *Archiv. für Mineralogie u. s. w.*, 1839, xii, 385), whose conclusions in regard to these alloys appear to be perfectly correct, with the exception of a few unimportant details. As is the case with the able research of the elder Mallet, the details of which are to be found only in the Report of the Tenth (Glasgow) Meeting of the British Association, for the Advancement of Science, p. 258, the very meagre abstracts of this memoir which are given in the chemical journals and text-books fail to convey a correct idea of the results which have been obtained,—a fact which may serve to explain the ignorance which has been exhibited, in regard to them, by subsequent experimenters."

‡ Figured in the memoir.

but their edges have the rounded character of the edges of the crystals This general character is maintained throughout the whole series o crystals, from those of pure copper down to those of the lowest white alloys which I have obtained. No doubt can possibly be entertained of the complete resemblance of these crystals to each other throughout the series, while the striking similarity to the well-known crystals of pure copper (obtained by fusion) which they exhibit, strongly indicates that they belong to the regular system. As it is of course impossible to measure the angles of such crystals, they cannot be crystallographically determined; but the most obvious conclusion is, that they are monometric. This opinion, however, must be based rather upon analogy than on any distinct measurements.

"Upon the assumption that the crystals which I have described belong to the regular system, as well as upon the fact, which will appear in the sequel, that none of the crystals have been found to contain any larger quantity of either of their component metals than was contained in the remainder of the molten liquid from which they had separated, I have based my conclusion that the alloys of copper and zinc are isomorphous mixtures* of the two metals."

"On this hypothesis it is of course presumed that both copper and zinc are capable of crystallizing in the regular system. Copper, as is well known always occurs in forms of the monometric system. But in regard to zinc this has not been so satisfactorily proved. Not only, however, does analogy indicate that zinc should be monometric—for, so far as is known, all the metals of the Three Series of Cooke† allied to it crystallize in forms of this system—but Nicklès‡ has actually observed an instance in which it occurred in the form of pentagonal dodecahedrons."

This observation of Nicklès having been called in question by Nœggerath and G. Rose, Mr. Storer takes occasion to defend it, maintaining that it is entitled to as much confidence as any of the observations of the crystalline form of zinc which have hitherto been made.

A minute description with figures of the crystals as obtained from alloys of various composition follows. These crystals vary in size according as a larger or smaller quantity of the alloy is allowed to become solid before piercing its crust, some of those obtained by the author exceeded half an inch in length, others were quite minute.

"Very fine groups of crystals were obtained from those alloys which contained only one or two per cent of zinc. It is worthy of note, that, although these crystals have the same form and general appearance as those prepared by the same method from an equal quantity—three or four pounds—of pure copper, they are nevertheless much larger and more perfect. Since they may, for all practical purposes, be considered as crystals of copper with slight impurity of zinc, and are easily to be obtained,

* "It must not be supposed that this view supports in the least the idea of the older chemists, that alloys were mere 'mixtures' of their component metals. For the experiments of Karsten (*loc. cit.*, pp. 398, 400) have already shown that the comportment of the alloys of copper and zinc towards acids, and the solutions of various metallic salts, is that of chemical compounds, being entirely unlike that of a simple mechanical mixture of the two metals, or of a mixture of several alloys."

† Memoirs of the Amer. Acad., [N. S.] v, table to p. 256.

‡ Ann. Ch. et Phys., [3,] xxii, 37.

it would almost seem advisable to add one or two per cent of zinc to the metal employed in preparing specimens of crystallized copper for the cabinet. A similar case is presented by lead, which is very readily crystallized when it contains a little antimony: a fact well exemplified by the beautiful cups of crystals of *Krätzblei*, which are prepared by partially cooling the metal in ladles, at the Fraukensharner smelt-works near Clausthal, and doubtless in other localities in the Hartz."

"Since the crystals rich in copper which have just been described do not possess in any marked degree the yellow color peculiar to brass, they are somewhat less interesting than those obtained from alloys containing more zinc. Crystals of the latter can be obtained with the greatest ease by remelting old brass, or, better, by filling a Hessian crucible from the molten metal of the pots of a brass founder, in which case all annoyance from the formation of a false crust of mixed oxyd of zinc and metal is obviated." * * *

"The most perfect individual crystals were obtained from a quantity of brazier's solder which had been prepared at the foundry of the Revere Copper Co., in Boston, by fusing together 50 parts of copper with 50 parts of zinc. When an alloy of about this composition solidifies, and especially if it be suddenly cooled—as happens when it is poured into iron ingot-moulds,—it assumes, as is well known, a highly crystalline structure, consisting almost entirely of a mass of coarse fibres which shoot out from the points at which the alloy comes in contact with the cold metal of the mould. In the instances which have fallen under my notice the ingots being from an inch to an inch and a half in depth the fibres have shot up three quarters of an inch, or more, from the bottom of the ingot, leaving only a sheet of metal about a quarter of an inch in thickness on top, which had cooled more slowly by contact with the air. * * * On removing portions of this upper layer, its inferior surface will be found studded with crystals, often of great beauty, while others frequently occur impacted among the fibres themselves. Indeed, these fibres, although described by Calvert and R. Johnson* as prismatic crystals, indicating that the alloy Cu Zn is a definite chemical compound, are evidently nothing more than collections of octahedral crystals, similar to those which form the fibres of sublimed sal-ammoniac and of several metals."†

The tendency to shoot out into fibres just alluded to which extends over quite a space from alloys containing 57 or 58 per cent of copper down to those containing only 43 or 44 per cent is next discussed. It is of peculiar interest on account of its practical bearing;—"alloys at the upper limit of this fibrous tendency being the lowest—*i. e.*, richest in zinc —which can be rolled or subjected to the various processes by which metals are wrought. Singularly enough, at a point just beyond the limit at which the fibres cease to be apparent, viz., at 60 per cent of copper, an alloy of peculiar homogeneity occurs;—its fracture as seen when small bars are broken, being smooth and compact, and entirely unlike either the coarse, irregular, stringy fracture of alloys richer in copper, or that of alloys containing only a little more zinc, upon the fracture of which small bundles of fine crystalline fibres are often apparent.

* Journal of the Franklin Institute, [3,] xxxvii, 200. See also Phil. Trans., cxlviii, 367.

† *Vid.* Savart, Ann. de Ch. et Phys., [2,] xli, 65.

"This alloy readily admits of being rolled, either hot or cold, and may be subjected to the operations of hammering or drawing without detriment, while alloys containing only a few per cent more copper can be rolled hot only when the sheets are raised to a very high temperature. * * *

"In the preparation of the alloy of 60 per cent copper, now so extensively used for sheathing vessels under the name of Muntz's sheathing or yellow-metal,—also known as malleable brass,—it is the custom of founders to reserve a portion of the zinc which has been weighed out for a charge, until the alloy in their pots or furnace has become sufficiently hot; the last portions of zinc are then added in small pieces, a sample of the alloy being tested after each such addition. This is done by dipping out a small portion of the melted mass and pouring it into a mould; a little ingot, five or six inches long by an inch or less in thickness, is thus obtained, which after cooling, is broken on an anvil, and its fracture observed. If this does not exhibit a smooth and homogeneous surface, more zinc is added to the alloy. The accuracy with which an experienced workman can thus obtain the desired alloy is truly astonishing, the more especially since this homogeneous alloy is confined within very narrow limits."

"It is stated by founders that the alloy of 60 per cent of copper and 40 per cent of zinc will present almost precisely the same homogeneity of fracture, whether the test ingot prepared from it be cooled slowly, by exposure to the air, or rapidly, by plunging it into cold water, while alloys containing either more or less than 60 per cent of copper are liable to assume different structures, according as they are cooled with greater or less rapidity. Two ingots are therefore sometimes cast, on each trial of the alloy, one of which is cooled in water and the other in air for comparison. This double test is, however, deemed superfluous by skillful workmen."

"I may remark in this connection, that I have repeatedly obtained crystals, by the method of partial cooling, from portions of melted yellow-metal taken from the founder's pots at the moment it had afforded them a satisfactory test. These crystals are in no wise different from those obtained by myself from alloys of almost identical composition.

"Although, as has been stated, the tendency to form fibres seems to have ceased at the alloy containing 60 per cent of copper, I cannot but think that the limit of its influence is less clearly defined than the "test" of yellow-metal founders would seem to indicate. In the circumstances under which this test is applied, it is doubtless true that no fibres are formed; but it is a matter of experience with manufacturers of yellow-metal, that the texture of the large ingots from which the sheets of sheathing are rolled is no longer so homogeneous as that of the small test ingot; they affirm also that this texture may vary greatly, according to the conditions in which the ingot is allowed to cool. It is evident, therefore, that during the processes of hot and cold rolling, and of annealing, to which the alloy is subsequently subjected, its texture may undergo various changes; while it is certain that the comparative durability of the sheathing, when exposed to the action of sea-water, must in great measure depend upon its relative compactness. If it be open and porous, as would be the case if a trace of the fibrous structure were present, it is clear that the sheathing would soon be destroyed;—not only because the salt water would come in contact with its interior portions, but also since the individual crystalline fibres of the alloy would doubtless resist its action more completely than the amorphous matter attached to them or contained in their interstices; from this a voltaic action would be produced, which could not fail to promote the corrosion of the alloy."

(To be concluded.)

II. GEOLOGY.

1. *On Prof. J. W. Dawson's papers on the Coal.*—Prof. J. W. DAWSON, LL. D., of McGill College, Canada West, has lately published in the Proceedings of the Geological Society of London two very interesting memoirs:—one concerning the vegetable structure in coal;* the other on a terrestrial mollusk, a *Myriapod* and some new species of reptiles from the coal of Nova Scotia.

The formation of the coal and the composition of its combustible matter may be considered as settled questions. But we are still far from being well acquainted with the true nature of the coal plants, and with their generic and specific affinities. Fossil plants are found preserved in two different ways. In the shales and the sandstones the outline of the vegetable is marked just as it would be on the stone by the pencil of a lithographer; but no trace of internal structure is preserved; and as these remains are mostly broken parts of stems and of leaves, crushed cones, scales or blades, nutlets and prints of various forms left on the bark of some trees at the point of attachment of the leaves, it is nearly impossible to determine with precision the species to which such fragments belong, or at least to get any indication about their mode of vegetation and their relation to plants now living.

In the coal on the contrary we find a few remains of internal organism, chiefly vessels of various appearances. But in the compact, homogeneous matter of the coal, every trace of external structure of the plants having disappeared, these isolated vessels can not, in any way, indicate the form of the plant to which they belong.

It is especially in treating the laminæ of mineral charcoal intermixed with compact coal by chemical maceration, that Prof. Dawson has been able to separate the vegetable fibre and to study the form of some of the vessels. The result of these researches is satisfactory to this point; it proves by a direct experiment that the coal is a compound of different species of plants. Though many palæontologists had already come to the same conclusions by researches of the same kind, Prof. Dawson is the first who has succeeded in clearing the woody fibre perfectly from every particle of amorphous substance, and thus his assertions are more conclusive and more reliable. Nevertheless, some of these assertions are open to critical discussion.

The first question which the author proposes to elucidate by his researches (the one which relates to the precise genera and species of plants which have contributed the vegetable matter required for the coal) is perfectly well answered by himself in a note from a former paper where he says: *I have little confidence in the establishment of genera or species, on the minute structure of fragments of wood.* Of course if fragments of fossil wood can not indicate genera and species by their internal organization, *à fortiori*, neither can isolated vessels do it. The second question concerning *the causes which have produced the different qualities of coaly matter observable in the different parts of the same bed, or in different beds in the same coal-fields*, does not appear to be satisfactorily answered. Suppose we admit Liebig's theory, that coal results from the submersion of vegetable fibre:—then since the thin laminæ of mineral charcoal,

* Vol. xv, 626.

generally no thicker than the $\frac{1}{30}$th part of an inch, alternate sometimes with equally thin layers or laminæ of compact coal, the question arises how could such thin layers be exposed to atmospheric influence while the intermediate laminæ were transformed to solid coal by immersion? The supposition *that the mineral charcoal represents the woody fibre of trees subjected to atmospheric decay, while the bark of those trees appears as compact coal along with such woody and herbaceous matter as might be imbedded before decay had time to take place*, is contradicted by numerous observed facts. In the coal-fields of the United States the layers of charcoal most frequently show prints, easily identified, of the species predominant in the shales overlaying the coal. Thus one bed (No. 1B Coal) has, especially in its charcoal, blades of *Lepidostrobus* and leaves of *Lepidodendron*. Others have in abundance the prints of the bark of *Calamites*, *Lepidodendron*, *Stigmaria* and even *ferns*.

The question whether *Stigmaria ficoides* be the root of a *Sigillaria* is far from being settled, and though the assertion that *Stigmaria* is found in every bed of fire clay is true, the deduction drawn from this fact, on the assertion of some authors—that *Stigmaria* is not found in the coal or in the shales overlaying it is without any foundation whatever. Some beds of coal have been formed by *Stigmaria* only. Whole strata of black laminated roof-shales contain only remains of *Stigmaria*.

Neither the form or the size of the scalariform vessels can be admitted as a generic character; the form of the perforations varies on the same vessel passing from round to oval, to equilateral and to true scalariform shape by gradual and inappreciable transitions. The size of the vessels varies according to the size of the same plant.

One of the most interesting conclusions reached by Prof. Dawson is that the small cylindrical filaments, resembling black threads, so abundant in the coal and mineral charcoal are composed of *bundles* of scalariform vessels inclosed in a sheaf of woody fibres. This is, says the author, precisely the structure of the vascular bundles of the petioles of ferns. It is certain that the writer has seen these filaments generally in connection with crushed stems, especially with crushed *Calamites*.

The vessels figured 8 to 12 of pl. 18, apparently belong to some species of *Stigmaria*, especially to *S. ficoides* (compare Corda's *Beytrage*, tab. 13). That tissue of this kind constitutes by far the largest part of the mineral charcoal is a proof of my assertion, that *Stigmaria* enters largely into the formation of the coal.

It is scarcely possible now to refer the genus *Sigillaria* to *Cycadea* or to the *Coniferæ*. Neither the internal structure nor what we know of the external forms of species of this genus, the leaves, the fruits, &c., can show such an analogy.

Prof. Dawson can not with certainty affirm the presence of tissue of true Conifers in the coal. This agrees perfectly with the result of ten years of explorations by the writer in the coal measures of the United States and its flora, where no trace of a true Coniferous plant has thus far been found.

The writer does not think that the coal measures of Nova Scotia give a true exhibition of the general formation of the coal. The coalfields of that country bear testimony to such continual disturbance by the repeated movements of the surface, repeated overflows, sudden invasions of littoral

debris, sand, pebbles, &c., that any general conclusion founded on the study of such geological phenomena, would be contradicted by what we see in the distribution of the coal strata in the coalfields of the United States, at least in those west of the Appalachian mountains.

The general conclusions of this paper, appear to be perfectly just, though not necessarily derived from the microscopical researches of Prof. Dawson. But, if this assertion of the author is true; that the *sigillariæ especially, have contributed to the vegetable matter of the coal;* what becomes of the former conclusion: that the filaments so abundantly found in the coal and mineral charcoal are bundles of fibrous vessels of petioles of ferns. Moreover we must deny the prevalence of *Calamites* and *Sigillariæ* in the roof shales, at least, in the coalfields of the United States. Each bed of coal, according to its age, or geological horizon, has some plants peculiar to itself predominating in the shales, and the same plants are found, apparently in the same proportion, in the whole thickness of the coal.

In his second paper,* Prof. Dawson most satisfactorily confirms a former discovery made by himself and Sir Charles Lyell, of the presence of terrestrial animals in the coal measures of Nova Scotia. In like circumstances, viz., in the hollow petrified trunk of a standing tree, he has found numerous well-preserved specimens of the same land shell, *Pupa vetusta* Daw., before discovered at the same locality; some remains of a new genus and species of an articulated animal, resembling a Myriapod, *Xylobius Sigillariæ* Daw.; and portions of two skeletons of animals belonging to a new *reptilian* genus, *Hylonomus* Daw., two species of which *H. Lyellii* Daw., and *H. aciedentatus* Daw., are figured and described in the paper.

Every geologist will recognize the great importance of this discovery, as respects both palæontology and the history of the coal formations. This history is slowly unfolding itself by the unwearied researches of a few true lovers of science, who like Prof. Dawson, endeavor to compensate the want of coöperation in such a thankless field of science as that of fossil botany, by incessant and conscientious labor. Discoveries of nearly the same kind as those of Prof. Dawson, have been made lately both in Europe, and in the United States. Goldenberg has found in the coal measures of the Vosges, in France, new species of *Blattinæ, Thermites, Dyctioneuron*, &c., and five wings of a *Blattina* have been lately found in the lowest coal of Arkansas. L.

2. *Thirteenth Annual Report of the Regents of the University of the State of New York*, (for 1859), 128 pp. 8vo. Albany, N.Y.—The cover and title page of this Report bear the date of 1860, with the addition, "made to the Senate, April 10, 1860." It contains in addition to the usual annual statement of the business affairs of the State Cabinet, six Appendises. Of these, A, B, C and D are catalogues of various collections and donations. The Appendix, E, is an interesting paper entitled "Ancient Monuments in Western New York, comprising the results of explorations by T. Apoleon Cheney, Civil Engineer, etc., 1859." It is illustrated by 24 plates and a map of various mounds, excavations and antiquities of the aboriginal inhabitants of the country.

Appendix (F) has a separate title page thus: "Contributions to Palæontology, 1858 and 1859. By JAMES HALL, *Geologist* and *Palæontologist*, etc." We are thus particular in noticing these dates because

* Quart. Jour. Geol. Soc. London, xvi, 268, 1860.

we have been informed that Prof. Hall has introduced into this paper under new names several species which have been described by other authors during the year 1860. Should this Appendix be separated from the Report and circulated with no other information as to the date than what is given on the title page, palæontologists in other countries may possibly be led to quote its contents with a date as far back as 1858.* From what appears upon the cover of the Report itself most people would suppose the date of publication to be April 10, 1860. Such however is not the fact. We have ascertained that "the first lot of (this) Regents' Report was delivered (by the Printer) Dec. 17, 1860, to the Regents of the University," (letter from C. Van Benthuysen, the printer). We have evidence that important changes were introduced into the text of the Geological part as late nearly as the above date, if not even later. Such additions should have been indicated by an appropriate date either in the text or on the cover of the Report. We regret extremely to feel compelled to make this statement. But having been long aware that similar changes had been made in the 12th Report, after it had been in part circulated and noticed in this Journal (xxviii, 149), we cannot permit this recurrence of the same practice to pass without our earnest protest. We would therefore respectfully suggest to the Regents that hereafter they should take every precaution to prevent this confusion of dates in the publications that issue under their authority. The interests of science demand that all misunderstandings between naturalists should be guarded against, and nothing can be more likely to make a man of science feel that he has been unfairly dealt with than to see another obtaining priority over him by fictitious or indefinite dates. Another Regents' Report will be due either in the present month of March or perhaps in April. Let it be printed and circulated *as presented* at once, or if it be delayed to accommodate authors, let the date of actual *publication* be given as well as the date of presentation to the Senate.†

Prof. Hall's paper contains notices of about one hundred (mostly new) species of fossils from the Silurian and Devonian rocks of the United States. He proposes the following new genera of Brachiopoda:

1. Skenidium.—This genus if adopted will include several species heretofore referred to *Orthis;* the dorsal valve flat and the ventral valve of a pyramidal shape.
2. Ambocœlia.—The types of this group are said to be *Orthis umbonata,* Conrad, and *Spirifer unguiculus,* Sowerby. It is therefore the same as McCoy's genus Martinia. (See McCoy's British Palæozoic Fossils, p. 377.)
3. Vitulina.—The species resemble *Orthis* with the dorsal valve flat,—the ventral valve pyramidal,—ribs large.
4. Leiorhyncus.—Shells with the general form of *Rhynconella* but with the "plicaticns more rounded, and rarely or never continued to the lateral margins

* In confirmation of this suggestion we have received (January 19,) a brocheure from the author entitled: "*Contributions to Palæontology,* 1858 *and* 1859 *By James Hall, Geologist and Palæontologist, etc.* (From the Thirteenth Annual Report of the Regents on the State Cabinet,) pp. 55–128, 8vo." On the cover there is the same title but the date there reads, "1858 *and* 1859 *with additions in* 1860." This is still too indefinite.

† No principle is more thoroughly established in the ethics of science than that the date of *publication* and not the date of *composition* or *printing,* settles the question of priority of authorship. Hence has arisen the practice of Authors of distributing separate copies of Memoirs in advance of publication of an official report—thus securing the earliest practicable date of *publication.* To this course no objection can be made, but no changes from the original text are admissible.

which are more compressed than in *Rhynconella* proper. The internal structure appears, so far as ascertained, to be the same as in *Meristella*" = (*Athyris pars*)?

5. MERISTELLA.—Intended to include that group of species of *Athyris* (McCoy) which has *A. tumida* Dalman, for the type. It is not probable that this proposal will be accepted because, if McCoy's genus is to be divided, then we have three names (long in use) to be accommodated, that is to say, *Athyris*, *Spirigera* and *Merista*. No new names can be admitted until all the old ones shall have been provided for.

Athyris, must be retained for the group with the beak of the ventral valve imperforate and closely incurved and with the mesial septum in the dorsal valve. (Type *A. tumida.*)

Spirigera, must include those with the beak of the ventral valve perforated and a rudimentary mesial septum in the dorsal valve. (Type *S. concentrica.*)

These two genera are limited as above by DAVIDSON in his "Introduction to the Classification of the Brachiopoda," pp. 84–87: and by F. RŒMER in the last edition of Bronn's "Lethaea Geognostica," vol. i, Pt. 2, p. 330–331. It is quite clear that if *Meristella* be retained then either *Athyris* or *Spirigera* must be suppressed in order to make a vacancy for it. There is no probability of this being agreed to by palæontologists. The other genus *Merista* will no doubt hold good for those species which have the shoe-lifter process in the ventral valve.

Prof. Hall describes a new genus of Crinoids under the name of *Cheirocrinus*, and also proposes two new genera of trilobites *Barrandia* and *Bathynotus* to include the peculiar forms from Vermont heretofore referred by him to the genus *Olenus*. It has perhaps escaped Mr. Hall's notice that McCoy has published a trilobite genus "*Barrandia*" in the "British Palæozoic Fossils," p. 149. McCoy's genus appears to be disputed but still it must be retained until it is clearly shown to be without foundation.

3. *Geological Surveys.*—TENNESSEE. Prof. Safford is now publishing the first volume of his Report on this State. It will be in two parts. 1st. The Physical Geography of Tennessee, 2d. The Geological Structure and the Formations of Tennessee. It is in 8vo, and will contain a map of the State and 20 or 30 plates, chiefly fossils. Its completion is expected in about three months. A *second volume* to be published hereafter, will contain Part 3d, the Minerals and mineral resources of the State, and Part 4th, the Agricultural resources.

KENTUCKY.—The publication of the fourth and concluding volume of this Survey is in the hands of Dr. Robert Peter, of Lexington, Ky. The matter will form a large and very valuable volume. The Legislature ordered 7000 copies to be printed. The completion of the work may be expected during the coming summer, if political causes do not arrest the progress of the work.

TEXAS.—We learn with regret that the removal of Dr. Shumard (noticed on p. 124) was caused solely by political considerations—his successor being an "Old Texian," which Dr. Shumard was not! An intimation that influential scientific names had been used to effect this change appears to have no foundation in fact, and was probably intended only to justify so remarkable a step. The effect of the change will probably be to abolish the work at the next session of the Legislature.

4. *Trilobites of the Wisconsin 'Potsdam.'*—Upon examination of the "small trilobites" from the Potsdam sandstone from "Black River Falls," Wisconsin, presented to the Boston Society of Natural History by Prof. Daniels, as mentioned on page 310 of vol. vi of the Society's Proceedings, they are found to be identical with the *Conocephalites minutus* from Keeseville, N. Y. Accompanying them are fragments of two or three

other small small trilobites too indistinct for absolute determination; one *seems* to be nearly allied to the genus *Bathyurus* (Billings). The specimens also contain a *Theca*, apparently *T. triangularis* (Hall); as also a few *Lingulæ*, which, while they *may* be *L. prima* of New York, yet vary so much that their identity seems hardly possible. F. H. BRADLEY.

5. *Chrome Garnet.*—I have recently discovered a beautiful emerald green garnet in Oxford, Canada, in calcareous spar with millerite. It is massive, granular, or in transparent dodecahedrons and resembles ouvarovite, but is essentially a lime-alumina garnet with 6·0 p. c. of oxyd of chromium. I shall soon send you a full description with an analysis.

Montreal, Jan. 21st, 1861. T. S. HUNT.

III. ZOOLOGY.

1. *Contributions to the Natural History of the United States;* by LOUIS AGASSIZ. Vol. III.—*Acalephs in general—Ctenophoræ.* Nothing goes farther to prove the necessity of a wide and far-reaching study of animate nature than the facts brought to light by the examination of jelly-fishes. It is the misfortune of most zoological text-books, and of popular science in general, that such stress is laid on the structure of Vertebrata, so many illustrations drawn from them, and so much emphasis given to them, as the head and type of the animal kingdom, and the scale by which all other animals are to be measured, that the student gets to look on everything else as something intrinsically inferior in character and uncertain in position.

This wrong idea is well illustrated by the expression Vertebrates and Invertebrates, as if the first were a division equal to, and co-extensive with, the second. Invertebrates are a common refuge for all creatures so unfortunate as to have no back-bone; just as Infusoria furnish a convenient reservoir, into which to pour all small objects that cannot easily be seen. Again, naturalists are led, by such partial studies to make many false generalizations; such as, that the rapidity and force of motion are in direct ratio to the size of the nervous centres and to the perfection of the muscular system; whereas we see such medusæ as *Coryne* (*Sarsia*) and *Pleurobrachia* executing swift and complicated motions, though they have neither nervous nor muscular systems, properly so-called. Then the incorrect homologies that are attempted: the comparison of the head-ganglion of a cephalopod to the brain of a mammal; the structure of a worm to that of *Petromyzon;* and of the limbs of an insect to the limbs of the higher vertebrates. To this may be added the false ideas of rank among the different groups; placing the whole of the Articulata below Vertebrata; the whole of the Mollusca below Articulata, and the whole of the Radiata below Mollusca. Whereas no such comparisons can be made between the different plans of creation, and no such systematic subordination established. The squids, among Mollusca, so far as they can be compared, stand certainly as high as any of the crabs, and possibly higher than the lamprey eels. The radiate *Spatangus* is, without doubt, a more complex mechanism than the molluscoid *Vorticella*, or the articulate *Rotifera*.

Books like this third volume of "Contributions" will do much to give to the mass of scientific men, those broad and philosophical views, which are now almost confined to the leaders. We here have revealed to us, in all its richness, a class which includes in its apparently humble

limits some of the most extraordinary phenomena of generation, of growth and of life.

The first chapter treats briefly of the history of our knowledge in this branch, from the time of Aristotle, (who confounded sea-anemones and jelly-fishes under the common term *nettles*), down, through many barren centuries, to near our own day, when Rondelet, three hundred years ago, published figures of medusæ, with some observations of his own. Two centuries more added comparatively little to the store of information; O. F. Müller, however, had published the *Zoölogia Danica*, the colored plates of which are fitting forerunners of the magnificent drawings of Lesueur, illustrating the numerous acalephæ, collected by him and his companion, Peron. The *System der Acalephen* by Eschscholtz, which not only embodied all heretofore known, but was further enriched by the material accumulated during two voyages round the world, served to show the great number and variety of these animals. The important exploring expedition of Quoy and Gaimard in the Physicienne and the Astrolabe; of Prof. Dana, in the expedition under Capt. Wilkes; and of Fitzroy in the Beagle, have done much to complete the necessary specific knowledge.

The first discoveries of Sars in the embryology of medusæ are striking illustrations not only of the gradual way in which zoölogical truths are arrived at, but also of the mistakes which come from a partial knowledge of any animal. They show that we cannot judge the embryo from the adult, or the adult from the embryo; and, what is yet more important, they exemplify the fundamental fact, that the embryo of a superior class resembles the perfect creature of an inferior class, in the same type. It was in 1829, that the Norwegian naturalist described a new genus of polyps under the name of *Scyphistoma*, and another peculiar one, of medusæ called *Strobila*. In 1841, through his own discoveries and those of other naturalists, he was enabled to prove, 1st, that *Scyphistoma* was the first stage of *Strobila;* 2nd, that *Strobila* was the fixed stock, which by transverse division, produced individuals of the genus *Ephyra;* 3rd, that a species of *Ephyra* was the young of *Aurelia aurita;* and 4th, that the eggs of *Aurelia aurita* produced a species of *Scyphistoma;* the two ends of the line of growth were thus joined and the cycle of the species perfected. In this way were the foundations laid for a general embryology of the covered-eyed medusæ. The connection between the so-called hydroid polyps and the naked-eyed medusæ, was yet to be shown. In 1843, Dujardin supplied the wanting link, by discovering that the medusa *Cladonema* was the offspring of the hydroid genus *Syncoryne.* The other two orders, Ctenophoræ and Siphonophoræ, do not present embryological difficulties of the same sort; the first named have young resembling the parent, though with shorter rows of flappers; somewhat as spiders, among insects, have no proper larval condition, but gain another pair of legs on coming to maturity.

It would be natural to challenge the standing of a class, containing such seemingly heterogeneous groups. What have they in common? Not a common embryology:—not a common detail of structure:—least of all a common *form.* Here then we are compelled to resort, to what we should daily resort to, without compulsion, the *metaphysics* of zoölogy. If we agree to call that a class which shows a plan of structure carried out in a peculiar way; then two questions come up: 1st, what is the peculiar way in which the general plan of radiation is carried out among

the Acalephs? and 2d, do all the so-called Acalephs really agree in the way in which the plan of radiation is through them exemplified? The peculiar model, so to speak, of a jelly-fish may best be seen by contrasting it with a polyp; for instance an *Actinia*;—and first it is plain that the jelly-fish carries the so-called stomach of the polyp turned *inside out*, and forming the proboscis (compare *Rhizostoma*, *Cyanea*, &c.); even where there is no proper proboscis, the stomach is not inverted into the body (*Bolina*, &c.). What is commonly spoken of as the stomach of a medusa is nothing more than the visceral cavity, into which open the radiating tubes, just as the free chambers of the polyp open into its visceral cavity. The jelly-fish has however a circular tube, running round the edge of the disc, and making a common receptacle for all the radiating tubes; a feature not found in the polyps. Then the fleshy interambulacral partitions, so thin and regular among polyps, are thickened, among medusæ, and coalesce above and below, leaving only narrow, radiating tubes through their gellatinous mass. With the model thus hastily sketched, all Acalephæ will be found to agree. The Ctenophoræ, which Quoy and Vogt would (no one can tell why) refer to Mollusca, are readily homologized. Taking *Idyia* as an instance, there is the visceral cavity, the circular marginal tube and the radiating tubes leading into it. The peculiar appearance of this particular group rises from their unusual height, their little rows of tentacles, called "flappers," and the arrangement of their parts in 8's, instead of 4's. It is in the order of Siphonophoræ that the triumph of class homologies has been the greatest;—here we are forced at once to take an embryological view, just as we are in considering the lampreys in connection with the fishes, or the marsupials, in connection with the mammals. Knowing that hydroids are one stage of true Acalephæ, and taking *Hydractinia* in comparison with any siphonophorous community, like *Velella*, we see that the polymorphous individuals may be compared in the two; *Hydractinia* is attached, *Velella* is free; the expanded base of *Hydractinia*, from which rise the different hydræ, forms in *Velella* the swimming vesicle. If further proof were needed the "tentacles" (hydræ) of *Velella* actually produce *free medusæ*. Such elongated communities as *Diphyes* may, in like way, be homologized; there are a few medusoid individuals ("swimming bells"), then hydroids ("polyps") protected by a "scale" and bearing on their proboscis male and female medusæ buds ("ovaries").

Not the least interesting addition to the hydroid medusæ is the discovery, by Prof. Agassiz, that *Millepora alcicornis*, of the Florida reefs, belongs to this division, and not to the actinoid polyps. It becomes hereby probable, that the whole of Milne Edwards' division *Tabulata*, which includes *Millepora*, *Pocillopora*, &c., is to be considered as among the Acalephs; and, further than this, his Rugosa, which include only fossil genera, are so distinct in many respects from the true stony corals, and so remind us in some genera, of the *Strobila* stage among the covered-eyed medusæ, that we are led to suspect *their* affinity also with the acalephæ. Be this last as it may, it is now pretty well established that jelly-fishes are represented, through the millepores, in some of the earliest geological formations; a point of the greatest importance in palæontology.

A proper review of Part II, on Ctenophoræ, could not be brought within the limits of this short notice. It consists of a critical analysis of Ctenophoræ in general; a consideration of their natural families; thorough

anatomical investigations of the North American species of *Bolina*, *Pleurobrachia*, and *Idyia ;* a systematic tabular view of the known Ctenophoræ; and a table of their geographical distribution. Among the most interesting of these investigations are the variations of form as dependent on the development of different "spheromeres" or radiating wedges of which the body is made up; and the remarks on the circulation of chyme.

The illustrations by Sonrel, Burkhardt, and Prof. Clark, are unrivalled in their way; Sonrel's large drawing of *Cyanea arctica* is a miracle of skill and patience. T. L.

Note.—The important chapter on individuality among acalephs is not mentioned here, because it has already appeared in this Journal, (vol. xxx, 142).

IV. ASTRONOMY.

1. *Translation of the Sûrya-Siddhânta, a Text-book of Hindu Astronomy*, (Journal of the American Oriental Society, vol. vi).—We take pleasure in bringing to the notice of our readers, and especially those who are students of astronomy, this highly important contribution to the history of that science. Ever since India began to open itself to the knowledge of the western nations, about the middle of the last century, it has been well known that the Hindus have a peculiar system of astronomy, which is neither recent in its origin nor inconsiderable in its development. The curiosity and interest which this fact could not fail to awaken, are attested by numerous works which relate, wholly or partly, to the Indian astronomy—the productions either of European savans, like Bailly, Delambre, Biot, or of Englishmen resident in India, as Davis, Colebrooke, Bentley, Warren, and many others. It is remarkable, however, that while so much has been written on the subject, no work has appeared before the present, from which the occidental scholar could find out what the Indian astronomy is,—how it exists, as a system of theory and practice, a science and an art, in the Indian mind. It is the want of any such work, which has given rise to the publication before us. Rev. Mr. Burgess, formerly missionary of the American Board of Missions, while laboring among the Marâthas of western India, was called upon to prepare an astronomical text-book for the instruction of the natives. In executing this task, he was, naturally and almost unavoidably, led to study the astronomical system of the Hindus themselves. He found, however, much to his surprise, that there was no published book, from which he could obtain, in a comprehensive and systematic form, the information which he wanted. The perception of this deficiency suggested the idea of supplying it. To facilitate for others the acquisition which cost him so much time and trouble, he determined to translate one of the *Siddhântas*, or astronomical treatises, of which there are a considerable number (for the most part, yet unpublished) in the Sanskrit language. He selected for this purpose the Sûrya-Siddhânta, which appears to be the most highly esteemed and the most generally used of these works. In preparing his translation, and in gathering matter for an explanatory commentary, he received the aid of native Pandits. He left India, indeed, without having accomplished his design; but desiring still that his work should be made available for the

cause of science, he placed his collected materials at the disposal of the American Oriental Society. The result appears in the sixth volume of the Society's Journal, in an article of 350 pages (more than half the volume), of which a separate edition has also been struck off, and can be obtained, at $2.50 a copy, from the Society's agents (New York, John Wiley, 56 Walker st., etc.). It has been prepared by Mr. William D. Whitney, Professor of Sanskrit in Yale College, and Corresponding Secretary of the American Oriental Society. In revising the translation, he has aimed to make it, not only faithful, but also in some degree intelligible, by expanding the condensed expressions of the original, and by giving English equivalents for the scientific, technical, and mythological terms which abound in it. In the last case, however, the demands of the Sanskrit scholar are satisfied by adding the original terms enclosed in marks of parenthesis. We say, "*in some degree* intelligible"; for a mere translation, however skilfully executed, would of necessity present numerous and almost insuperable difficulties to the occidental reader. These difficulties arise, partly, from modes of conception peculiar to the Indian mind; partly, from peculiarities in the methods and processes of the Hindu arithmetic and geometry; partly, from the fact that the work is composed in Sanskrit verse,—a mixture of poetry and science which is familiar to the Hindus, though to our view incongruous and absurd. The style of the original is exceedingly condensed and cramped, and its language often vague and ambiguous. In fact, it was never intended for easy reading. It was not meant to be an open source, from which an unlearned man could draw out for himself the knowledge of astronomy; but rather a secret repository of astronomical science, accessible to the initiated, and employed by them for the uses of instruction, the teacher supplying in his own oral comments the indispensable explanation.

To remove the difficulties of which we speak, Prof. Whitney has added a copious and elaborate commentary, which follows the translated text from point to point, and not only illustrates its meaning, but compares its principles and processes with those of European astronomy. It presents the results of long and careful study in a perspicuous and attractive style, which cannot fail to interest all who are capable of taking an interest in the subject. The demonstrations which are given to show the correctness, or (as the case may be) incorrectness, of the Hindu rules and methods, are drawn out with much fullness and clearness, and offer no difficulty to those who have a fair acquaintance with the elements of geometry and trigonometry. It appears from an acknowledgment in the introduction, that Mr. H. A. Newton, Professor of Mathematics in Yale College, has rendered important assistance in the preparation of this commentary.

The subject of Eclipses is treated with particular care. This may be regarded, indeed, as the centre of Hindu astronomy, the great end of astronomical pursuits among that people being the prediction of these phenomena. Besides his remarks in illustration of the text, Prof. Whitney has given an extended calculation of the lunar eclipse of February 6, 1860, made by himself in strict conformity with the data and methods of the Sûrya-Siddhânta. We find also a calculation, according to Hindu data and methods, of the solar eclipse of May 26, 1854; this however, was mainly prepared for Mr. Burgess by his Hindu as-

sistant, and it illustrates, as we see from the accompanying criticisms, the negligence and looseness with which the methods of their books are applied in practice by the native astronomers.

One of the most interesting chapters is that which relates to the *nakshatras*, or lunar asterisms, a series of star-groups, twenty-eight in number, encircling the sphere, and seemingly known to the Hindus from a very early period. Prof. Whitney, in his learned and masterly discussion, compares these Indian *nakshatras* with the *sieu* of the Chinese and the *manâzil* of the Arabs. He comes to the conclusion that they did not originate in India; but he shows at the same time, that they were not brought, as Biot supposed, from China into India; if they originated in China, they must have been carried first to some country of central Asia, where they received a modified form, and thus afterward passed into India on the one hand, and into Arabia on the other, to undergo further special modifications in each of these countries.

The relations of the Indian science of astronomy to that of the Greeks are often noticed in the course of the commentary, and form the subject of a closing note, which sums up in a very clear, and, to our mind, convincing manner, the results to be drawn from the foregoing expositions. The conclusion, in brief, is this, that the Hindu science must be regarded as an off-shoot from the Greek, planted not far from the commencement of the Christian era (probably before the time of Ptolemy), and attaining its fully developed form in the course of the fifth and sixth centuries. Among the points of agreement between the two systems, the most striking is the use of epicycles for representing the motions, and calculating the positions, of the planets. This is a cardinal feature in both systems, and is essentially the same in both. There is no reason to suppose that the Greeks borrowed it from the East, but much reason for believing the contrary. To regard it as originating in India is opposed to all we know of the scientific character and tendencies of the Hindus. Acute as they are and fond of speculation, they have never shown an aptitude for the study of external nature, and could not have made the exact and long-continued observations of the stars, on which that system must have been founded; their books, indeed, contain no records of astronomical observations. The division of the circle also presents traces of a Greek origin; and the Greek names for *minute*, *hour*, *centre*, are found in the Hindu text-books. The Greeks, in fact, are, not unfrequently, referred to in the treatises of earlier date, as authorities on astronomical subjects. But the Hindus, if they borrowed the Greek astronomy, have set upon it the stamp of their own thinking; they have given it, in general, an arithmetical, instead of a geometrical, form; and have made a really valuable improvement by substituting, in their calculations, the sines of arcs for the chords which were used by the Greek mathematicians.

We must add, however, that Mr. Burgess does not accept these conclusions. In a note appended to the article, he sets forth his dissenting views, maintaining the originality of the Hindu science, and contending that the features common to the two systems were either developed independently in both countries, or were imported into Greece from the East.

The value of the work is much increased by a copious index, which furnishes to those who may not care to study it as a whole, the means of finding readily all that it contains on any particular topic.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Interesting discoveries of Saurian and other fossil remains in the Red Sandstone of E. Pennsylvania, in a letter from* C. M. WHEATLEY, Esq., of Phœnixville, Pa., to one of the Editors.—I have within the last three months made some important discoveries in our black shales of the Phœnixville Tunnel. I have found a true "*Bone Bed*" and have obtained from it *Saurian Bones* of very great interest, whether *Clepsisaurus* Lea, *Centemodon* Lea, or *Omosaurus* Leidy, is difficult to determine. These fossils are on masses of rock, too large for removal; they comprise *vertebra*, *ribs*, *tibia*, *femur*, *coracoid*, and other bones. I will describe the bones on the masses of rocks as I obtained them, viz.:

On No. 1. Concave vertebra 2¼ *inches* in diameter with spinous process 6 inches long from centre of vertebra, and other bones.

On No. 2. Part of a very large bone 3½ inches long measuring across largest end 2½ in. and at smallest 2 in. with ribs, vertebra, and other bones.

On No. 3. Fine large bone 7 inches long, 2 in. diameter at smallest end, 3¼ inches over condyles. This bone has a *large medullary cavity.* Another bone on same rock is 10½ inches long, diameter at smallest end 1½ inches: a coracoid on same stone, with other parts. Other pieces exhibit ribs, vertebra, spinous process, teeth, coprolites, some with scales and bones of Ganoid fishes in them.

Equisetum calumnare! very fine specimens 15 to 16 inches in circumference and 7 in. long, the first time it has been noticed this side of Richmond (Va.) Coal Basin.

Pterozamites longifolius like those figured in Emmons's North Carolina Report. *Gymnocaulus alternatus* Em. *Fir Cones*, 3 in. long, 1 inch wide, two species of *Estheria*, *Cypris*, *Myacites*, *Pennsylvanicus* Conrad, and a lot of undetermined fossils—some very like *Crustaceans* and *possibly* remains of *Insects.*

2. *Upheaval of the sea and inundation at Kahului and Maliko, Maui, Sandwich Islands.*—A sudden tide wave occurred on the 2d of December, 1860, along the coast of East Maui, lying between Kalului and Maliko, and extending farther on toward the Hana district, a distance along the shore of some twenty-five miles. The wave, of which there was but one on this occasion, rose about eight feet, and resembled the same phenomenon which occurred in that district some twelve or fifteen years ago, and which consisted of several waves, following each other at short intervals. It took place during the night, and created some consternation among the natives. No serious damage was done, though two or three native huts at Maliko are reported as having been removed from their foundations, and a wharf or staging erected by the new sugar company at the same harbor were carried inland and left high and dry, when the water receded. These phenomena are no doubt caused by the volcano of Mauna Loa, which by a submarine eruption creates a disturbance in the sea.—*Pacific Advertiser*, *Honolulu*, *Dec.* 12, 1860.

We look with interest to the tidal register of the Coast Survey to learn whether this vibration was felt along the Pacific Coast of this Continent as in the more remarkable case of the great upheaval at Jeddo in 1854.

3. *Dr. Cooper's reply to Gov. Stevens's charge of Plagiarism in* vol. xxx, p. 302.—We have received a long letter from Dr. Cooper dated at San Francisco, Nov. 20, 1860, in which he reviews the charges of Gov. Stevens with more detail than the public interest in the controversy warrants, or than our space can admit.

Dr. Cooper's manly explanation of the origin of Gov. Stevens's complaints which we give below, and the laudable spirit which characterizes his communication, at once relieves this gentleman from any suspicion of intentional injustice to Gov. Stevens, and renders the publication of other details needless.

Dr. Cooper states that he assisted Gov. Stevens largely in the preparation of the Chapter on Meteorology. While he disclaims any intention of appropriating any of Gov. Stevens's labors, he adds that "nothing but the accident of his arriving at Washington (in July 1859) after the work was printed, had prevented his giving credit to Gov. S. for the authorship of the Chapter on Meteorology."

"I have offered," says Dr. Cooper, "to Gov. Stevens, in a letter, (which he did not wait to receive before publishing his reclamation for my 'plagiarism,') to go the expense of an extra title page to the Chapter on Meteorology, without mention of my own name. This can be sent to each owner of a copy to be pasted in before the Chapter, and will give credit more conspicuously, than if his name was in the general title page of the book."

"I have offered to consider any plan which he may esteem preferable."

As Dr. Cooper also proposes, "to refer to the Editors of this Journal the question of the propriety of his making farther acknowledgments or concessions"—we have only to say, while we believe that Gov. Stevens will be satisfied with the disclaimers and explanations of Drs. Cooper and Suckley, we cannot doubt that it would have been more satisfactory to all parties had the general title page of the "Contributions to the Natural History of Washington Territory," stated in substance "that these observations were made in connection with the Expedition to survey routes for a Pacific Railroad from the Mississippi River to the Pacific Ocean near the 47th and 49th parallels of N. latitude, under command of Gov. I. I. Stevens."

4. *Fulgurites or Lightning tubes.*—Dr. Hitchcock informs us (Nov. 20, 1860) that he has received from Dr. A. Cobb, of Montague, Mass., "specimens, which appeared to be some kind of slag, more or less tubular, with the cavities glazed on the inside and rough on the outside; looking externally somewhat like branched coral; the branches nearly an inch in diameter and flattened. In short, it was obviously fine sand which had been fused by heat on the inside of the mass, so as to form a thin pellicle of brown glass. The specimens were found at Northfield Farms, in Massachusetts, on what was supposed to be an old Indian camping ground, or battle-ground." They are obviously fulgurites.

5. *New Meteorites from Hindostan.*—Two meteoric stones fell on the 28th of Feb., 1857, near the village of Parnallee in Southern Hindostan, about noon from a cloudless sky—one of them weighing about 37 pounds, has reached this country as a gift from Rev. H. S. Taylor, to whom we owe the history of the fall, to the Cabinet of Western Reserve College, Ohio. A description of this stone will appear in our next.

6. ***Results of a Scientific Mission to India and High Asia* 1854 *to* 1858, *by Hermann, Adolphe and Robert de Schlagintweit.***—We have received the Index to vol. i. of this important work, together with four large maps, of which No. 1 shows the routes taken by the Brothers Schlagintweit through India and High Asia; No. 2 shows the lines of equal magnetic declination; No. 3 the lines of equal magnetic dip; and No. 4 the lines of equal magnetic intensity throughout India as far north as lat. 40°. This work is published in quarto in the best style by Brockhaus of Leipsic, and forms an important contribution to our knowledge of terrestrial magnetism. When the entire work has been received we propose to give a full account of its contents. The maps are very perfect specimens of cartography and chromatic printing.

7. "*The Botanical Society of Canada,*" an institution of great promise, was established at Kingston, Canada West, on the 7th of December last, at a meeting called for the purpose at Queen's College, the Rev. Principal Leitch in the chair. Principal Leitch is the President of the Society, and Prof. George Lawson, Secretary. We have read with great interest the report of one or two meetings of this Society, at which valuable papers were read, and we learn that arrangements are made for the publication of the botanical papers of permanent interest which are read before the Society.

8. *Assinniboine and Saskatchewan Exploring Expedition.*—Prof. Hind's interesting narrative of his explorations in this region (see vol. xxx, p. 288,) is about to be published by Longmans in London, in an 8vo, the neatly reduced maps for which edition have reached us.

9. *The American Association for the Advancement of Science.*—This body adjourned to meet at Nashville, Tennessee in April next. The Local Committee had fixed on the 17th of April, the third Wednesday, as the day of meeting. We learn however that there is a possibility the Standing Committee, who have charge of the affairs of the Association *ad interim*, acting with the Permanent Secretary, will advise a postponement of this meeting for one year, owing to the disturbed condition of public affairs.

OBITUARY.

10. MAJOR JOHN LECONTE.—This well known naturalist died at Philadelphia, on the 21st of November, 1860, aged 77, having been born at Shrewsbury. N. J., Feb. 22, 1784. He entered the corps of U. S. Engineers in 1818, and derived his title of Major from that service. His chief contributions to science have been in botany and zoology. Dr. Coates has been requested to preface a notice of his life for the Am. Phil. Society.

11. CHARLES W. HACKLEY, Professor of Mathematics and Astronomy, in Columbia College, died in New York, Jan. 11, 1861, of a nervous fever. He was born in Herkimer Co., N. Y., in 1809, entered the U. S. Military Academy at West Point in 1825, and was Assistant Prof. of Mathematics there from 1829 to 1832. Leaving military life he studied theology and entered Episcopal orders in 1835. He was Professor of Mathematics in the University of New York from 1833 to 1839, when he was elected to the Presidency of Jefferson College, in Mississippi. From the year 1843 up to the time of his death he filled the chair of Mathematics in Columbia College, N. Y. He was the author of several elementary scientific works—a "Treatise on Algebra," pnblished in 1846, an "Elementary Course

on Geometry," which appeared in 1847, and "Elements of Trigonometry, with their Practical Application to Navigation and Nautical Astronomy."

Book Notices.—

12. *Illustrated Catalogue of Philosophical Apparatus;* by Edward S. Ritchie, No. 313 Washington st., Boston, 1860, pp. 84, 8vo. Also *Ritchie's Catalogue of School Apparatus.*—Mr. Ritchie's catalogues attest the neatness, skill and good taste with which his apparatus is prepared. The Illustrated Catalogue enumerates many pieces of physical apparatus not heretofore included in the catalogue of American instrument makers. Teachers will be agreeably surprised by an examination of the Catalogue of School Apparatus to find how much may be done for a very modest sum in illustrating the principles of physics.

13. *Education: intellectual, moral, physical;* by Herbert Spencer, Author of "Social States," etc., etc. New York, D. Appleton & Co., 1861. 8vo, pp. 283.—We have examined this book sufficiently to be able to say that the style of it is vigorous and the matter condensed without the sacrifice of clearness. It is composed of four essays, bearing the following titles: I. What knowledge is most worth? II. Intellectual Education. HI. Moral Education. IV. Physical Education. These were originally published in the English Reviews. The discussions are able and suggestive; and will, in one particular at least, be likely to gratify the students of nature, inasmuch as they warmly insist on the superior advantages of science over languages, in the culture of youth. The author belongs to the school of Compte, and the deficiencies of his treatise, especially under the topic of moral training, are to be ascribed to this circumstance. On the whole, however, while the attention of the reader is strongly drawn to the profound importance of the general subject of education, the views taken in the book are commonly well sustained.

We observe also that it is proposed to issue by subscription, Mr. Spencer's System of Philosophy, comprising First Principles, 1 vol. The Principles of Biology, 2 vols. The Principles of Psychology, 2 vols. The Principles of Sociology, 3 vols. The Principles of Morality, 2 vols. Messrs. D. Appleton & Co., 443 and 445 Broadway, N. Y., are the American publishers.

VI. BOOKS RECEIVED.

The Report of the British Association, Aberdeen, 1859. (From the Association.) London, 1860. 8vo, pp. 310 and 312.

Magnetical and Meteorological Observations. St. Helena. Vol. II. 1844–49. Printed by the British Government under the superintendence of Maj. Gen. Edward Sabine. London: Longmans. 4to, pp. 526. Presented by the British Government.

Occasional papers on the Theory of Glaciers by James D. Forbes, D.C.L., F.R.S. Edinburgh: Black. 1859. 8vo, pp. 278.

Siluria: The history of the Oldest Fossiliferous Rocks, &c., by Sir Roderick Impey Murchison, &c., &c. Third edition (including "*The Silurian System.*") London: John Murray. 1859. 8vo, pp. 592, 41 plates. [The two last valuable works by the carelessness of a forwarding agent reached us *two years* after date.]

Thirteenth Annual Report of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History. Made to the Senate, April 10, 1860. Albany, 1860. (See notice on p. 292.)

The Manufacture of Vinegar, its Theory and Practice with especial reference to the Quick Process; by C. M. Wetherill, Ph.D., M.D. Philadelphia: Lindsay & Blakiston. 1860. 12mo, pp. 300. (A review prepared for this No. will appear in our next.)

Manual of Geology: designed for the use of Colleges and Academies; by EBENEZER EMMONS. Illustrated by numerous engravings. Philadelphia: Sawyer, Barnes & Co. 1860. 12mo, pp. 290.

Patent Office Report (Agriculture), 1859. 8vo, pp. 589. Washington.

Coal, Petroleum, and other Distilled Oils; by ABRAHAM GESSNER, M.D., F.G.S. 8vo, pp. 134. Baillière Brothers, N. Y. 1861. (See notice in No. 91, p. 147.)

Geological Report of the Country along the line of the Southwestern Branch of the Pacific Railroad in Missouri; by G. C. SWALLOW, State Geologist. St. Louis, 1859. 8vo, pp. 93.

History, Theory, and Practice of the Electric Telegraph; by GEO. B. PRESCOTT. Boston: Ticknor & Fields. 1860. 12mo, pp. 468.

Annual Report of the Board of Regents of the SMITHSONIAN INSTITUTION, showing the operations, &c., for 1859. Washington, 1860. 8vo, pp. 450.

Warren's Descriptive Geometry, Orthographic Projections; by EDWARD WARREN, C. E. New York: John Wiley. 1860. 8vo, pp. 412. (See notice in No. 91, p. 148.)

JAHRESBERICHT der Chemie Physik, Mineralogie und Geologie für 1859. Giessen, 1860. 8vo, pp. 903.

Geological Survey of Canada. Reports of Progress for the year 1858. Montreal, 1859. 8vo, pp. 263. (See notice in No. 91, p. 122.)

Geological Survey of New York. Palæontology: Vol. III. Containing Descriptions and Figures of the Organic Remains of the Lower Helderberg Group and Oriskany Sandstone, 1855–1859. By JAMES HALL. Part I: Text. Albany: printed by C. Van Benthuysen. 1859. 4to, pp. 532.

Memoirs of the Literary and Philosophical Society of Manchester. Vol. XV. (*Second Series.*) London: H. Baillière. 1860. 8vo, pp. 316.

Philosophical Transactions of the Royal Society of London, 1850 to 1859 inclusive. 4to. From the Royal Society.

New American Cyclopedia: a Popular Dictionary of General Knowledge. Appleton & Co., N. Y. Vol. XI. 8vo, pp. 788. MAC—MOX.

NICKLÈS, J.—Les Electro-aninants et l'adhérence magnétique. 8vo, 5 planches. *Elacroix.* 2 copies.

Il Nuovo Cimento, Giornale di Fisica, Chimica, E Storea Naturale; Direttori MATTEUCCI, PIRIA, MENEGHINI. Tomo IX, X, XI. Torino, Pisa. 1859–1860.

Répertoire de Chimie Appliquée; Comptes Rendu des Applications de la Chimie en France et a l'Etranger par BARRESWIL. Tome I et II, 1859. 1860. Paris.

Répertoire de Chimie Pure; Compte Rendu des Progrès de la Chimie Pure en France et a l'Etranger par M. AD. WURTZ. Paris. Tome I et II, 1859–1860.

Der Zoologische Garten Organ für die Zoologische Gesellschaft der Dr. WEINLAND. Frankfurt *a.* M. Heft 1–12. 1860.

Polytechnisches Notizblatt. Herausgegaben und redigirt von Prof. Dr. RUD. BÖTTGER in Frankfurt *a.* M. 1860.

Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen. Afdeeling NATUURKUNDE. Tiende Deel. Amsterdam. G. Van der Post. 1860. 8vo, pp. 342.

The same, Afdeeling LETTERKUNDE. Vijfde Deel. 8vo, pp. 401. 1860.

The Natural History Review and Quarterly Journal of Science, by Profs. HARVEY, HAUGHTON, HOGAN and WRIGHT. London, 1860. 8vo.

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. IV, Part IV. Philadelphia, Dec., 1860. 4to, pp. 321 to 416.

First Principles; by HERBERT SPENCER. No. 1. Part I, The Unknowable. New York: D. Appleton & Co. 1860. pp. 80. (See notice on p. 304.)

Zeitschrift für Chemie und Pharmacie, correspondenzblatt, Archiv und Kritisches Journal für Chemie, &c. Von Dr. E. ERLENMEYER und Dr. G. LEWENSTEIN. Erlangen, 1860.

BROCHEURES.

Agricultural Chemistry.—

Experimental Inquiry into the Composition of some of the Animals fed and slaughtered as Human Food; by JOHN BENNET LAWES, R.R.S., F.C.S., and JOSEPH H. GILBERT, Ph.D., F.C.S., (from the PHILOSOPHICAL TRANSACTIONS, 1859). London. 4to, pp. 187:—

By the same authors—

Sheep-feeding and Manure. Part I. 1849.—Report of Experiments on the Comparative fattening qualities of different breeds of Sheep. Parts I, II, and III.—Pig feeding.—On the Equivalency of Starch and Sugar in Food.—On the Composition of Foods, in relation to Respiration and the Feeding of Animals.—Experimental Inquiry in the Composition of some of the Animals fed and slaughtered as Human Food.

On Agricultural Chemistry, especially in relation to the Mineral Theory of Baron Liebig.

Agricultural Memoirs by LAWES and GILBERT, continued.

On the amounts of, and methods of estimating, Ammonia and Nitric acid in Rain-water.

Report to the Right Hon. the Earl of Leicester, on experiments conducted by Mr. Keary, on the Growth of Wheat upon the same land for four successive years, at Holkham Park farm.

Reply to Baron Liebig's Principles of Agricultural Chemistry.

On the Growth of Wheat by the Lois Weedon system, on the Rothamsted soil; and on the combined Nitrogen in Soils.

On the Growth of Barley by different manures, continuously on the same land, and on the position of the crop in rotation.

On some points in the Composition of Wheat-grain, its products in the mill, and Bread.

Report of experiments with different manures on permanent meadow land, (with tabular appendix).

Report of experiments on the Growth of Red Clover by different manures.

Letter on the Utilization of Town Sewage.

Discourse on the Composition of the Animal portion of our food, and on its relations to Bread. (Abstract.)

On the Sewage of London.

Lectures on Agricultural Chemistry, delivered at the Smithsonian Institution, Dec. 1859, by Professor SAMUEL W. JOHNSON, of Yale College, Connecticut.

GEOLOGY.—

On the Silurian and Devonian rocks of Nova Scotia; by J. W. DAWSON, LL.D., F.G.S.

Notice of Tertiary Fossils from Labrador, Maine, &c., and Remarks on the Climate of Canada, in the newer pliocene or pleistocene period; by J. W. DAWSON.

On the Vegetable Structures in Coal; by J. W. DAWSON, LL.D., F.G.S., &c., Principal of M'Gill College, Montreal. From the Quarterly Journal of the Geological Society, Feb. 1860.

On a Terrestrial Mollusk, a Chilognathous Myriapod, and some new species of Reptiles, from the Coal formation of Nova Scotia; by J. W. DAWSON, LL.D., F.G.S., Principal of M'Gill College, Montreal.

MENEGHINI, CHEV. JOS.: Palæontologie de L'Ile de Sardigne. Supplément. 4to. Turin, 1860.

On certain theories of the formation of mountains. No. 1. E. BILLINGS, from the Canadian Naturalist and Geologist, December, 1860.

Description of New Fossils from the Palæozoic rocks of the Western States, from the Transactions of the Chicago Academy of Sciences, October 11th, 1859; contributed by J. H. MCCHESNEY. Extract No. 2.

Notice of Geological Discoveries, made by Capt. J. H. SIMPSON, Topographical Engineers, U. S. Army, in his recent Explorations across the Continent.

Descriptions of new Organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska; by F. B. MEEK and F. V. HAYDEN. By MEEK and ENGELMANN.

Descriptions of two new species of Carboniferous fossils, brought from Fort Belknap, Texas, by Dr. Moore; by W. M. GABB.

Descriptions of new Carboniferous fossils from Illinois and other Western States; by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey.

Descriptions of New Species of Crinoidea from the Carboniferous Rocks of the Mississippi Valley; by JAMES HALL. From Jour. Boston Soc. Nat. Hist., Jan. 1861.

The same in a different imprint. Abstract.

CHEMISTRY.—

Nuevo Metodo Para el Exámen de Química en el Establecimiento Cientifico de Latacunga. CARLOS CASSOLA, Profesor de Quimica, Ecuador, S. A.

A Manual of Qualitative Analysis; by D. K. TUTTLE, Ph.D., University of Virginia, and C. F. CHANDLER, Ph.D., Union College. Charlottesville, Va., Schenectady, N. Y. Albany, 1860.

On the Amounts of Lead contained in some Silver Coins; by CHARLES W. ELIOT and FRANK H. STORER. Proceedings of the American Academy, Sept. 11, 1860.

An Outline for the Quantitative Analysis of Urine; by HENRY ERNI, A.M., M.D., Professor of Medical Chemistry and Medical Jurisprudence in Shelby Medical College, Nashville, Tenn. Nashville, Tenn., 1860.

MINERALOGY.—

Mineralogie und Chemische Geologie. (Kopp's Jahrb., 1860.)

Recherches sur les Pseudomorphoses; par M. DELESSE.

Ermittelung Krystallographischer Constanten und des grades ihrer Zuverlässigkeit; von H. DAUBER, Assistenten am K. K. Hof-Mineralien-Cabinete. (Mit 5 Tafeln.) Wien, 1860.

Mémoire sur les Formes Cristallines et les Propriétés Optiques de la Zoïsite, de la Sillimanite et de la Wöhlérite, et Note sur une Nouvelle Disposition du Microscope Polarisant; par M. DESCLOIZEAUX.

On Tetradymite: reply to Dr. C. T. Jackson, of Boston; by F. A. GENTH.

Der Meteorit von St. Denis-Westrem im k. k. Hof-Mineralien-Cabinete; von dem w. M. W. HAIDINGER.

Die Calcutta-Meteoriten, von Shalka, Futtepore, Pegu, Assam und Segowlee im k. k. Hof-Mineralien-Cabinete; von dem w. M. W. HAIDINGER.

Der Meterorit von Shalka in Bancoorah und der Piddingtonit; von dem w. M. W. HAIDINGER.

Die Meteoriten des k. k. Hof-Mineralien-Cabinetes, am 30 Mai, 1860; W. HAIDINGER.

ZOOLOGY AND BOTANY.—

New Unionidæ of the United States and Northern Mexico. By ISAAC LEA, LL.D. 4to, 15 plates. Philadelphia, Nov., 1860.

Smithsonian Miscellaneous Collections.—Catalogue of the described Lepidoptera of North America. Prepared for the Smithsonian Institution by JOHN G. MORRIS. Washington: Smithsonian Institution, May, 1860.

Smithsonian Miscellaneous Collections.—Check Lists of the Shells of North America. Prepared for the Smithsonian Institution, by ISAAC LEA, P. P. CARPENTER, WM. STIMPSON, W. G. BINNEY, and TEMPLE PRIME. Washington, June, 1860.

Synonymy of the family Cyclades; by TEMPLE PRIME.

Catalogue of the Fishes of the Eastern Coast of North America from Greenland to Georgia; by THEODORE GILL. February, 1861.

Catalogue of the Phænogamous and Filicoid plants of Newcastle County, Delaware; by EDWARD TATNALL. Published by the Wilmington Institute. Wilmington, Del., 1860.

Catalogue of the Flowering Plants and Ferns of Ohio; by J. S. NEWBERRY, M.D. Columbus, 1860.

Additions to the Flora of Wisconsin; by T. J. HALE, University of Wisconsin.

MISCELLANEOUS.—

On Meteorology; by Professor JOSEPH LOVERING, of Harvard University.

Notes on the Apparent Universality of a principle analogous to Regelation, on the Physical Nature of Glass, and on the Probable existence of Water in a state corresponding to that of Glass; by EDWARD W. BRAYLEY, Esq., F.R.S., &c. From the Proceedings of the Royal Society, vol. x, p. 450.

On Luminosity of Meteors from Solar Reflexion; by R. P. GREG, F.G.S.

Binocular Vision, theory of Images on Transparent Media, and the Stereomonoscope; by C. J. WISTER, Jr., Germantown, Penn.

Remarks on the Aurora of August 28, 1859; by BENJAMIN V. MARSH.

Objects and Plan of an Institute of Technology, &c., proposed to be established in Boston. Boston, 1860. Prof. W. B. ROGERS.

Notice sur la vie et les traveaux de P.-A. Dufrénoy, suivie d'une liste Bibliographique de ses Publications; par A. D'ARCHIAC, lue a la Société Géologique de France. Dans la Séance du 21 May, 1860.

Report on the Huacals, or Ancient Graveyards of Chiriqui. A paper read before the American Ethnological Society, by J. KING MERRIT, M.D.

Bulletin of the American Ethnological Society.—On a Stone implement from New Jersey; by Dr. JOHN C. EVANS, of Pemberton, New Jersey.

Bulletin of the Wisconsin Agricultural and Mechanical Association. Milwaukie, 1860.

The Rock Oils of Ohio; by J. S. NEWBERRY. 1859.

The Penokee Iron Range of Lake Superior, with Reports and Statistics, showing its mineral wealth and prospects; by I. A. LAPHAM. Milwaukee, 1860.

Description and Key to Nystrom's Calculator, with Practical Rules and Examples for using the same; by J. W. NYSTROM.

Report on the condition of the Niagara Railway Suspension Bridge; by JOHN A. ROEBLING, Civil Engineer. 1860.

Catalogue des Principaux appareils d'Acoustique qui se fabrequent chez RUDOLPH KŒNIG, a Paris, Place du Lycée Louis-le-Grand, 5. 1859.

Science the true basis of Education.—An Address before the College of California, at Oakland, June 14th, 1860; by CHAS. ARTHTR ELY. San Francisco, 1860.

Modern Warfare: its Science and Art; by Capt. E. B. HUNT, Corps of Engineers, U. S. A. Read before the American Association for the Advancement of Science, at Newport, R. I., August 4, 1860. From "the New Englander," Nov., 1860.

Denkschriften der Naturwissenschaftlichen Gesellschaft Isis zu Dresden. Dresden, 1860.

Natural Selection not inconsistent with Natural Theology: A Free Examination of Darwin's Treatise on the Origin of Species, and of its American reviewers; by ASA GRAY, M.D., Fisher Professor of Natural History in Harvard University. Cambridge, 1861.

Illustrated Catalogue of Chemical Apparatus exhibited in the Educational Department of the Museum of Science and Art, South Kensington. I. I. Griffin. London, 1861.

A Notice of the origin, progress, and present condition of the Academy of Natural Sciences of Philadelphia; by W. S. W. RUSCHENBERGER, M.D., Surgeon U. S. Navy. Second edition, revised and corrected up to January 1, 1860, by the Author. Philadelphia, 1860.

Proceedings of the Essex Institute. Vol. II, Part 2. 1857 to 1859. Salem, 1860.

Charter, Constitution, By-Laws and List of Officers of the Wisconsin Natural History Association. Milwaukee, 1860.

Das Königliche Mineralogische Museum in Dresden geschildert auf Hohe Veranlassung von H. B. GEINITZ. Dresden, 1858.

VII. PROCEEDINGS OF SOCIETIES.

JOURNAL OF THE ACAD. NAT. SCI. OF PHILADELPHIA, (continued from vol. xxx, p. 160.) Vol. IV., Part IV., (N. S.), contains (Dec. 1860) Art. XII, Description of new birds of Western Africa, in the Museum of the Academy of Natural Sciences of Philadelphia; *John Cassin.*—Art. XIII, New Unionidæ of the United States and Northern Mexico; *Isaac Lea, LL.D.*—Art. XIV, Descriptions of New Species of American Tertiary and Cretaceous Fossils; *Wm. M. Gabb.*

PROC. OF ACAD. NAT. SCI. OF PHILAD. 1860. (Continued from vol. xxx, p. 160.)—145, Plants appearing in flower, in neighborhood of Philadelphia from Feb. to May, 68 species; *Dr. Darrach.*—146, Habits of the Beaver; *Smith.*—147, Occurrence of *Physa gyrina* in cisterns and water from Artesian wells in Alabama; *Lea.*—Diminution of petrolium in Pennsylvania Oil wells; *R. E. Rogers.*—148, European species of shells off Nova Scotia; *J. R. Willis.*—Modification of Gore's ball revolving by a galvanic current; *R. E. Rogers.*—Death of B. Henry, M D., announced. —149, Habits of the black Snake; *A. H. Smith.*—149, Rock-boring Mollusca; *I. Lea.* —150, Notes on American Land shells, No. 6; *W. G. Binney.*—154, Description of new species of Pulmonata in the collection of the Smithsonian Institution; *W. G. Binney.*—A list of Shells in the State of Wisconsin; *I. A. Lapham.*—156, Contributions to American Lepidopterology, No. 4; *Brackenrige Clemens, M. D.*—174. Description of a new species of Marginella; *J. H. Redfield.*—175, Descriptions of new organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska; *F. B. Meek* and *F. V. Hayden.*—186, Descriptions of fourteen new species of Schizostomæ, Anculosæ and Lithasiæ; *Isaac Lea.*—188, Catalogue of Birds from the Isthmus of Darien, collected by Lt. N. Michler, U. S. Top. Eng., with notes and descriptions of new species; *John Cassin.*—197, Descriptions of new species of Cretaceous Fossils from S. America in the collection of the Academy; *W. M. Gabb.*—199, Catalogue of plants in flower during the month of May near Philadelphia; *Dr. Darrach.*—201, Death of G. W. Carpenter noticed by resolution.—202, Remarks on Combustion; *R. E. Rogers.*—On the identity of Ammonites Texanus, ROEMER, and A. vespertinus, MORTON; *W. B. Gabb.*—203, Contributions to American Lepidopterology, No. 5; *Brackenridge Clemens, M. D.*—221, Hemiptera of the North Pacific Exploring Expedition under Com'rs Rodgers and Ringgold; *P. R. Uhler.*—231, Notes on Shells; *T. A. Conrad.*—233, The "Cutting Ant" of Texas (MYRMICA (ATTA) TEXANA); *S. B. Buckley.*—236, Contributions to the Carboniferous Flora of the United States; *H. C. Wood, Jr.*—241, Catalogue of the Colubridæ in the Museum of the Academy of Nat. Sci. of Philad., with notes and descriptions of new species, Part 2; *E. D. Cope.*—267, Synonymy of the Cyclades, a family of Acephalous Mollusca, Part 1, family CYCLAS 176 Nos., SPHÆRIUM 93 Nos.; *Temple Prime.*—302, List of plants in flower near Philadelphia in June, 1860; *Dr. Darrach.* —305, Descriptions of two new species of UNIONES from Georgia; three from Mexico; some Unionidæ from the United States; six from Alabama; and three exotic species; *I. Lea.*—308, Descriptions of new Fossil Remains collected in Nebraska and Utah, by the Expl. Expeditions under command of Capt. J. H. Simpson, of U. S. Top. Engineers [in advance of the official Report by sanction of Sec'y Floyd]; *F. B. Meek.* 315, Notes on the Coleoptera found at Fort Simpson, Mackenzie River, with remarks on Northern species; *J. L. LeConte.*—321, Synopsis of the Scaphidiidæ of U. States; *J. L. LeConte.*—324, Description of a new species of Cephalopod, from the Eocene of Texas; *W. M. Gabb.*—325, Descriptions of new species of American Freshwater Fishes; *C. C. Abbott.*—328, Descriptions of new species of North American Serpents in the Museum of the Smithsonian Institution, Washington; *Robert Kennicott.*—339, Notes and descriptions of new and little known species

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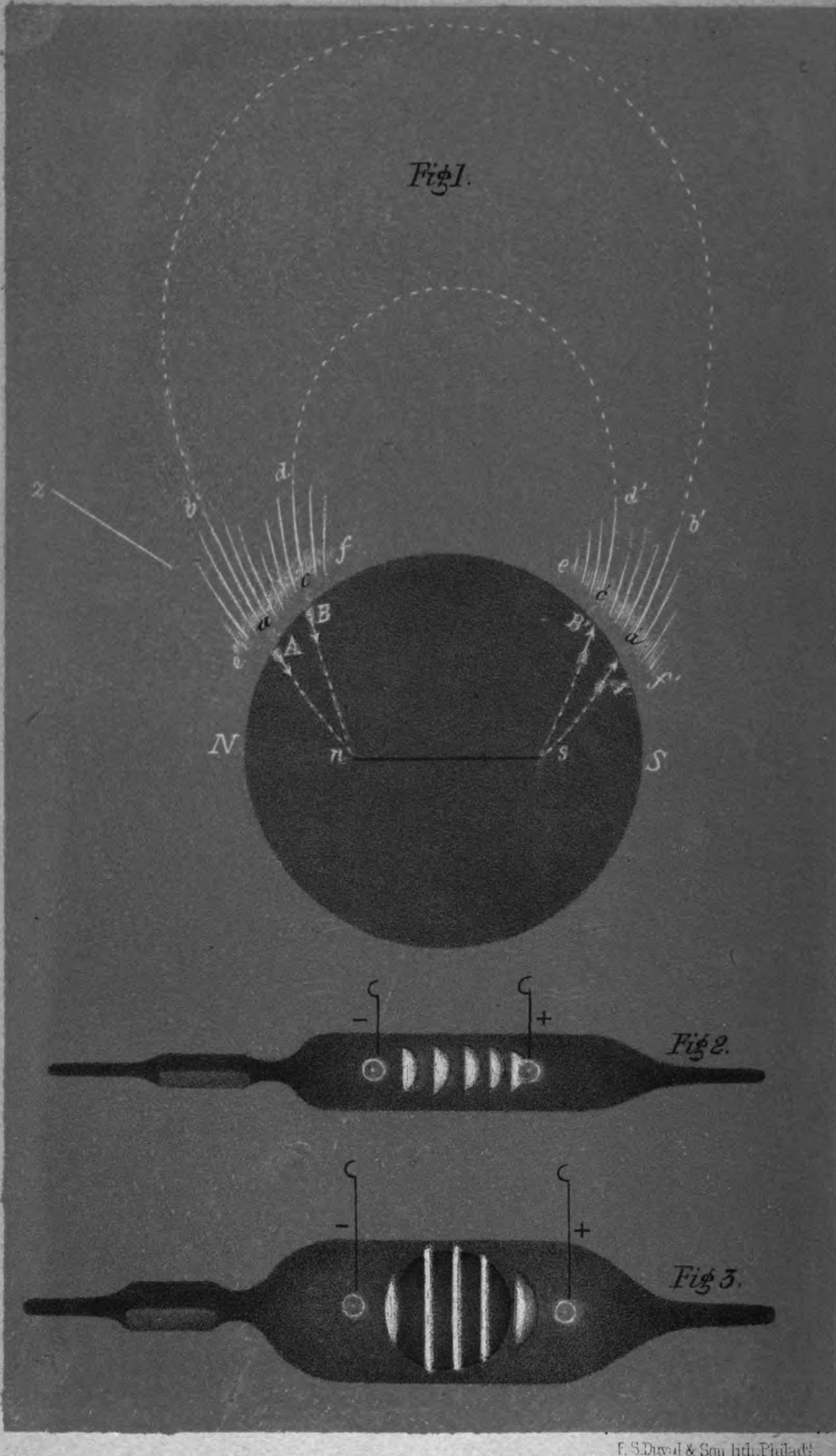

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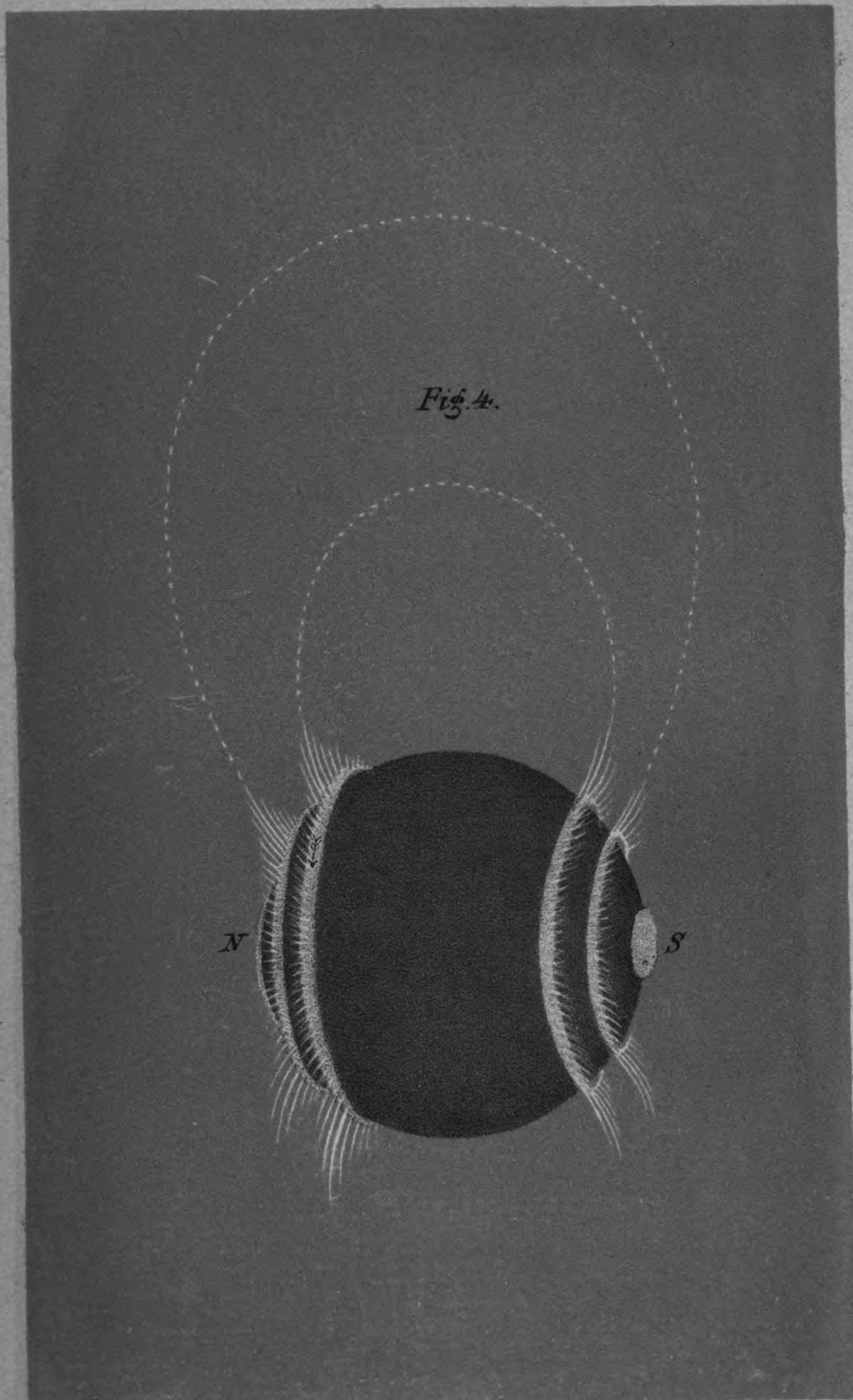
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[SECOND SERIES.]

ART. XXVII.—*The Aurora, viewed as an Electric Discharge between the Magnetic Poles of the Earth, modified by the Earth's Magnetism;* by BENJAMIN V. MARSH. With two plates.

IT was shown by Dalton that the appearances presented by the Aurora could be explained by supposing the existence of *horizontal bands* of luminous matter nearly at right angles to the magnetic meridian, and of *columns parallel to the dipping needle*, —the former constituting the auroral "arch,"and the latter the "streamers"—and he suspected that the streamers either stood upon the arch, or depended from it.

Subsequent observations have confirmed the reality of these bands and columns, and have shown that, ordinarily, *the streamers stand upon the arch as a base.* When the arch is nearly overhead we see the streamers through it, as through a curtain, and have no means of determining which is the more distant, both being in the same direction from the eye. But when, as more frequently happens, the whole display lies far to the north of us we can observe clearly the relative position of the parts. We then see an arch stretching over the northern horizon, with streamers standing upon the arch and not extending below it. The tops of the streamers may be at very unequal elevations but their bases will generally be found arranged in the regular curve of the arch—although when there are two concentric arches the streamers from the lower may appear to extend into the upper and thus render the phenomenon more complicated.

The auroral arch as seen over the northern horizon is generally a perfect and regular arc of a circle, its highest point being

nearly on the magnetic meridian and its extremities resting upon the horizon. This being true in all longitudes where observations have been made, it necessarily follows that the arch is always part of a circle, the centre (or rather the pole) of which corresponds very nearly to the magnetic pole of the earth.

In the great display of August 28th, 1859, the arches seemed to centre in the northeast as seen from California, nearly in the north from Philadelphia, and in the northwest as seen from England. So that there is great reason to suppose they were *rings, more or less perfect surrounding the north magnetic pole, and parallel to the surface of the earth beneath them.*

In the Journal of the Franklin Institute for November, 1859, I gave what appeared to me satisfactory evidence that on that occasion at half past 9 P. M. the most southern of these rings was about 300 miles wide (its northern margin being vertical over Newburyport, Mass., and its southern over Frederick, Maryland), and that it was about 43 miles from the earth—also that streamers near 580 miles in length and several miles in diameter, springing from this ring as a base, extended to a height of near 600 miles from the earth, the tops of the most southern streamers being vertical over Norfolk and being distinctly visible from Havana where they extended 23 degrees above the northern horizon. These streamers had a rapid but steady motion from *east to west,* that is they *revolved around the north magnetic pole of the earth in that direction.*

In this case then the lowest part of the auroral display being more than forty miles from the surface of the earth, where the rarity of the air must be fully equal to that attainable with the best air-pump, and the highest, extending far beyond what is ordinarily supposed to be the extreme limit of the atmosphere, it must be very difficult to imitate the whole phenomenon experimentally even if the subject were fully understood. But I desire to call attention to the very striking agreement between some of the essential features of the aurora, and phenomena observed by Plücker and Gassiot in their recent investigations in reference to the electric discharge in vacuo.

Prof. Plücker of Bonn, in a series of experiments on "the action exerted by a magnet on the luminous electric discharge passing through a tube or other glass vessel which contains residual traces of any gas or vapor," by passing the discharge from an induction coil through large Torricellian vacuum-tubes "of a cylindrical shape into which long wires enter from both ends," has succeeded in showing that the electric light passing from the negative wire towards the positive is "bent by the magnet into curves and surfaces."

He says (Proceedings of Royal Society, vol. x, No. 38, p. 258) "The magnet acts on this light in a peculiar way, having no analogy with phenomena hitherto observed. I easily discovered the law giving in all cases the exact description of the phenome-

non. The light emanating from any not isolated point of the negative wire and diverging in all directions towards the interior surface of the surrounding tube *is bent by the action of the magnet into the magnetic curve which passes through this point.*"

"Such a curve is the only one along which an electric current can move without being disturbed by the magnet. It equally represents the form which a chain of infinitely small iron needles absolutely flexible, and not subjected to gravity, would assume if attached with one of its points on the point of the negative wire. It is well known that a magnetic curve is completely determined by one of its points. Therefore the whole light starting from all the different points of the negative wire *will be concentrated within a surface generated by a variable magnetic curve.*"

"The negative light partly depends upon the substance of the wire. Particles of it, either pure or combined with the included gas, are carried off to the interior surface of the tube, which when platina wires are used, consequently is blackened. If not acted upon by the magnet all the parts of the surface surrounding the platina wire become black; *if acted upon, only that line along which the surface of the tube is intersected by the magnetic surface is blackened. In this case therefore the particles separated from the wire move along magnetic curves.*"

"The importance of the use of magnetic curves or lines of magnetic force, in experimental researches, has been shown by several philosophers, especially Mr. Faraday. Hitherto only filings of iron enabled us to give, in peculiar cases, an imperfect image of these curves. *We may now trace through space such a curve in the most distinct way and illuminate it with bright electric light.*"

Dr. J. Baker Edwards, who subsequently made somewhat similar experiments, in speaking of the light of the electric discharge through an exhausted tube, says, (Proceedings of Literary and Philosophical Society of Liverpool, No. 14, 1859, 1860, p. 134), "When this column of light is made to fall over the pole of an electro-magnet it is attracted in the direction of the magnetic curves and *rotates rapidly around the magnet*, the direction of its motion being reversed when the polarity is altered or the direction of the current is changed."*

Now if in these experiments we suppose the electro-magnet to represent the magnetism of the earth—the negative wire the auroral "arch"—and the lines of magnetic light the auroral "streamers," are not the phenomena absolutely identical?

* On page 681 of the second edition of Silliman's Physics, recently published and which I had not seen when the above was written, is a figure and description of Geissler's form of an apparatus first contrived by De la Rive to exhibit this rotation. Prof. S. says, "if an electro-magnet is enclosed in the electrical egg, and a very perfect vacuum is made within it, when the induction current is caused to flow, *the electrical stream is seen to revolve in a steady and easy manner about the magnet, the direction of its motion corresponding to the polarity of the magnet.*

In an aurora the centre of the corona being the vanishing point of the nearly parallel streamers which compose it, it is evident that a streamer having its base exactly in this centre (as *a b* or *c d*, fig. 1, Plate V,) must be seen absolutely endwise, and must appear merely as a bright spot in the centre of the corona—the line drawn from the base of this streamer to the eye of the observer (at A, or B, fig. 1) being a continuation of its axis. But it is found that this line always coincides with the direction of the axis of the dipping needle, at whatever place the observation is made, and, since the position of the dipping needle at any point on the surface of the earth is such that its axis lies in the magnetic curve passing through that point, it necessarily follows that the axis of the streamer in question must lie in a continuation of this magnetic curve, which for so short a distance may be treated as a straight line. Hence we must conclude *that every auroral streamer lies wholly in the magnetic curve which passes through its base.*

But an electric discharge from the parts of the atmosphere overlying the vicinity of the north magnetic pole, in passing toward the south magnetic pole, would, according to the law of Prof. Plücker, be compelled by the magnetism of the earth, to move along the magnetic curve passing through the point from which it starts. Hence as we find the auroral streamers occupying this very curve, presenting every appearance of streams of electricity, and revolving around the magnetic pole of the earth, just as Dr. Edwards observed the electric streams to do around the pole of the magnet, we seem justified in concluding that they really are *currents of electricity passing from the auroral arch on their way to the south magnetic pole, or perhaps to a corresponding arch surrounding it.* (See fig. 1, Plate V.)

If so it will probably be found that the phenomena in the two hemispheres, although simultaneous, are not identical, just as the appearances in the electric discharge in vacuo are widely different at the positive and negative terminals.

It is true that we have succeeded in tracing the streamers only five or six hundred miles, out of the many thousands they must traverse to reach their destination in the southern hemisphere, but their illumination even thus far beyond the supposed limits of the atmosphere is probably due in part to particles of matter carried from the arch, just as portions of the platinum wire were conveyed by the currents to the surface of the glass in the experiments of Prof. Plücker—and the invisibility of the streamers beyond this point may result from their great distance from the observer combined with the greater diffusion of the current and the absence of matter to be illuminated.*

* The experiment of Prof. Plücker shows that electric currents have a powerful tendency to transport portions of the electrode, the cohesion of even so hard a sub-

Whatever may be the material constituting the auroral arch, it does not seem capable of penetrating the denser portions of the atmosphere but rather glides over them with a horizontal motion. Its observed form and motions may perhaps be most readily explained by supposing it to originate as a horizontal stratum of cloud, of a circular form, having its centre vertical over the north magnetic pole. Such a cloud, if repelled by this pole and attracted by the south magnetic pole, must, in commencing its motion southward (if there be any coherence between its parts) be converted into a ring, which would glide over the upper surface of the atmosphere, its diameter constantly increasing, like that of a circular ripple in water, as it moved towards the magnetic equator. In this case the ring itself would always occupy the position of a magnetic parallel of latitude; and the part of it visible from any place on the surface of the earth would appear as an arch with its ends resting upon the horizon and with its highest point on the magnetic meridian. Other similar clouds successively formed over the pole and then impelled southward would present the same phases, and when they were sufficiently near to each other, an observer would see several concentric arches, as is the case in some auroral displays.

The material composing the arch seems, in the steadiness and mildness of its light, its rolling motion, and cloudy appearance, strikingly to resemble the "glow" which is frequently seen in electric discharges in vacuo and which is very remarkable in some forms of the "stratified discharge." In the "Proceedings of the Royal Society," vol. x, Nos. 38 and 39, Mr. J. P. Gassiot, in giving the results of numerous experiments upon the electric discharge through his carbonic acid vacuum tubes, describes many varieties of the "stratified discharge." In some instances several luminous cloud-like concentric envelopes sur-

stance as platinum being insufficient to resist it; and the great height to which auroral streamers are seen to extend renders it probable that their visibility is due to matter so transported from the auroral arch—and since they are illuminated instantaneously throughout their whole length, *the velocity of the particles of matter carried up must approximate to that of electricity itself.*

The auroral columns shooting up instantaneously to such immense heights and maintaining their rectilinear form while revolving, as they frequently do, with great angular velocity around the magnetic axis of the earth are strikingly analogous to the tails of comets shot out from the nucleus with inconceivable velocity and maintaining their rectilinear form while sweeping around the sun, in perihelion, notwithstanding their prodigious length and great angular velocity.

Comets frequently approach so near to the sun that we might well expect developments of electric energy incomparably surpassing anything presenting itself upon the earth; and if auroral currents can transport particles of our atmosphere to a distance of several hundred miles beyond its limits we may readily conceive that similar forces may carry portions of the extremely rare material composing the envelope of a comet to a distance of even millions of miles from the nucleus. The suspicion may therefore be indulged that *the tail of a comet simply indicates the position of a stream of electricity rendered visible by its illumination of particles of matter which it is constantly transporting from the nucleus with the velocity of electricity itself.*

rounded one of the terminals, whilst in others cloud-like masses of light were successively developed from one of the terminals, whence they passed towards the other terminal and were thus arranged in a line between them—their development being greatly promoted by the presence of a powerful magnet.

With a water-battery of 3500 cells, these are represented as faint and cloudy in their appearance; and with Grove's nitric-acid battery of 400 cells although the action was so intense that they became extremely bright they still retained their cloud-like form and motion. In describing experiments made with this battery, the exhausted receiver being placed between the poles of the large electro-magnet of the Royal Institution, Mr. G. says, "On now exciting the magnet with a battery of ten cells, effulgent strata were drawn out from the positive pole and passing along the upper or under surface of the receiver, according to the direction of the current. On making the circuit of the magnet and breaking it immediately, the luminous strata rushed from the positive, and then retreated, *cloud following cloud with a deliberate motion,* and appearing as if swallowed up by the positive electrode."

In another experiment with the nitric-acid battery Mr. G. says, "four or five cloud-like and remarkably clear strata came out from the positive." These were large lens-shaped masses arranged at regular intervals between the terminal wires, their flattened surfaces facing these terminals, as shown in fig. 2, pl. V, which is copied from Gassiot's figure (Proceedings of Royal Society, vol. x, No. 39, p. 401).

Now if in this case we imagine a small glass globe placed with its centre directly between the wires, it is evident that each of these cloud-like discs as it "came out from the positive" towards the negative terminal, must, while passing the glass globe be pierced by it, and be converted into a ring, (see fig. 3,) just as the auroral cloud was supposed to take the annular form in gliding over the spherical surface of the non-conducting atmosphere.

*This part of the auroral display may therefore prove to be some modification of the "stratified discharge"—the magnetic poles of the earth being the terminals, and the auroral arches being analogous to the cloud-like masses of light or glow described by Gassiot, the magnetism of the earth aiding in their development.**

* The following description of another of these experiments also seems suggestive of auroral phenomena:

"With the inductive coil the discharge in 146 exhibits a large cloud-like luminosity on the plate, which in those experiments was always made the negative terminal. On the positive wire minute luminous spots were visible. *At intervals apparently by some sudden energetic action, flashes of bright stratified light would dart through the vacuum,* but by carefully adjusting the contact breaker the discharge could be made to pass, producing a white glow on the negative plate, without, to the eye affording any appearance of an intermittent discharge."

In the "London, Edinburgh and Dublin Philosophical Magazine" for December, 1860, Prof. Rijke of Leyden mentions that M. Perrot had shown that the spark from a Ruhmkorff coil consists of a bright point of light combined with a "luminous atmosphere that admits of being displaced by a current of air or gas," which he had succeeded in separating from it; and that while the ordinary spark is entirely unaffected by magnetic force, "*this luminous atmosphere appears affected in precisely the same manner as the voltaic arc under similar circumstances.*" Now as the voltaic arc tends to revolve around the pole of a magnet, this "luminous atmosphere" or glow must do the same; and if the material composing the auroral arch be of the same nature we should expect it also to revolve from east to west, or the reverse, around the magnetic pole of the earth—the direction of its motion corresponding with that of the streamers. In the display of August 28th, 1859, such was actually observed to be the case, the fragments composing the arch, as well as the streamers, having a rapid motion from east to west.*

The foregoing considerations seem to render it probable that the aurora is essentially an electric discharge (see fig. 4, Pl. VI) between the magnetic poles of the earth,—leaving the immediate vicinity of the north magnetic pole in the form of clouds of electrified matter which float southward through the atmosphere at a height of forty miles or more from the earth, sometimes to a distance of more than thirty degrees from the pole; that whilst they are thus moving forward with a comparatively slow and steady motion, or sometimes even remaining almost stationary for a long time, bright streams of electricity are, from time to time suddenly shot out from them in a nearly vertical direction —that is to say in the magnetic curves corresponding to the points from which they originate: that these curves, ascending to a great height beyond the atmosphere, then bending more and more southward and downward until they finally reach corresponding points in the southern magnetic hemisphere, are the pathways by which the electric currents pass to their desti-

* The grand display of August 28th, 1827, seems to have been of a strikingly similar character. In "Hough's Meteorology of the State of New York from 1826 to 1852," p. 487, the observer at Lowville says, "The arc remained entire three-quarters of an hour, its highest point being at first about 10° north of the zenith, one of its extremities meeting the horizon a little south of east, and the other a little north of the west point. *During the existence of the arc its constituent matter passed in a rapid and ceaseless current from East to West;* and soon after the arc was formed it began to move (the extremities however advanced but little) in a southerly direction, and continued its progress until it descended as many as 40° south of the zenith, it then *was broken up into parallel pieces which moved majestically westward,* and gradually diminished in magnitude and lustre, till at length every vestige of the arc disappeared."

In most auroras the arch is situated so far north that it is too distant from observers in this latitude to permit them to determine anything as to the motion of its parts.

nation; and for several hundred miles from the earth these curves are thus "traced through space in the most distinct way and illuminated with bright electric light"—and further that the magnetism of the earth also causes these luminous currents and the electrified matter composing the arch to revolve around the magnetic pole of the earth, giving them the motion from east to west or from west to east, which the streamers and the components of the arch are observed to have.

DESCRIPTION OF PLATES.

Pl. V, Fig. 1.

N and S—The North and South magnetic poles of the earth.
n and *s*—The poles of an imaginary magnet representing the magnetism of the earth.
A, A′, B, and B′—Points on the surface of the earth.
ab, *cd*, *a′b′*, *c′d′* &c.—Auroral streamers.
ef and *e′f′*—Sections of auroral arches.
Z—The direction of the zenith to an observer at A.

The arrows show the position of the dipping needle at the several points A, A′, B and B′—and the dotted lines represent the magnetic curves passing through A and B.

An observer at A sees a corona having its centre at *a*—the streamer *ab* being seen endwise as a mere spot of light, and the streamers surrounding it appearing to diverge from it in all directions.

An observer at B sees a corona having its centre at *c*.

Fig. 2—Is copied from Gassiot's figure.
Fig. 3—Represents an imaginary modification of the same experiment.

Pl. VI, Fig. 4.

N and S—The North and South magnetic poles of the earth.

The East and West bands represent auroral arches, upon which stand the streamers. The dotted lines represent magnetic curves, and the arrow on one of the arches shows the direction in which the streamers, and the components of the arch revolved on the 28th of Aug., 1859.

Philadelphia, Jan. 31st, 1861.

Art. XXVIII.—*Remarks upon the Atoll of Ebon, in Micronesia;* by E. T. Doane.

We will begin our remarks upon the Atoll of Ebon by referring in a general way, first, to that section of Micronesia which embraces it, known as the *Marshall Islands.* The name is that given by *Krusenstern* in honor of Capt. Marshall who made the first discoveries there in company with Capt. Gilbert. The discoveries date back seventy-two years; the first island was seen in 1788, the last being discovered only in 1824.

The whole group lies within the longitudes 166° and 172° east, and 4° 39′ and 12° north latitude. Of the atolls of the group, some are large, measuring forty, fifty, and sixty miles in circumference, while others are mere bank-reefs, two or three miles in circumference. Of the large islands, we may mention *Jaluit* or Bonham's *Rimski Korsakoff*, or *Rong-rik* and *Rong-lab*,

and *Mille* or the Mulgrave Islands. Of the mere bank-reefs, we may mention *Kili* or *Hunter's* and *Lib* or *Princess* Island. And we would here remark, perhaps no group of the Pacific presents a more tangled mass in the nomenclature of its islands, than does the Marshall Islands, and especially the Ralik range. Some of the terms we have given above may perplex the reader as he attempts to trace them out on ordinary charts.

The Marshall Islands are divided by a deep sea about one hundred and fifty miles wide—into two chains—the Eastern or *Radak*, and the western or *Ralik*. Their general bearing is N.W and S.E. The Eastern chain possesses thirteen atolls and the western sixteen. The general features of these atolls are similar to those of most coral islands. They are low—the reef-rock in none probably measuring more than ten or twelve inches in elevation. In form, however, there is much diversity. *Mille* or Mulgrave island is nearly a parallelogram—*Majuro* or Arrowsmith is oval; *Ebon* circular—while *Jaluith* or Bònham's Island and *Arlinglab-lab* or *Elmore* Islands, and many others, are without any definite forms.

The atolls vary in fertility. Those south of 8° north latitude possess, from all native accounts, the most fertile islets and the most available soil. Their fertility may be accounted for from the fact, that more rain falls upon them. They are more affected by the equatorial belt of "constant precipitation" which is ever oscillating backwards and forwards over them. Dead leaves and wood rapidly decay.

It is an interesting fact, anomalous to the general features of coral islands, vide Dana's Coral Is. p. 24—that the *leeward side* of these islands possesses the largest body of land. Indeed the windward side of many of these islands is entirely destitute of land—or possesses it only in small islets. On *Mille* or *Mulgrave* Islands and *Majuro*, *Arrowsmith*, *Jaluith*, *Bonham's* Islands and *Ebon* islands which the writer has visited, this is emphatically true. The windward side of *Majuro* is possessed only of small islets, while the leeward side is one continuous strip of land, twenty-five miles long. *Jaluith* is much like this; perhaps, however, it has not so continuous a piece of land on the leeward side—though there is here the most fertile soil. On *Ebon* this is likewise true.

An explanation of this fact may perhaps be found, in the strong winds—the "N.E. trades" sweeping with all their force for one half the year over these reefs. These strong winds and the heavy sea they raise, tend to sweep off the material which might accumulate there; and bearing some portion on across the lagoon to the leeward side is there lodged, and helps forward most rapidly the accumulation of the "beach formation."

The fact has been stated, that the northern atolls of the Mar-

shall islands are rather subsiding than otherwise; vide Dana's Coral Is., p. 134. It may be asked, is this not rather apparent than real? May not the small amount of wooded land found there—for this is the basis of the statement—be owing rather to the heavy seas and winds which there prevail? The natives ever speak of the heavy winds of that latitude, 12° N. Islands have been desolated by them. We feel disposed to offer this as a solution of the fact.

Another fact, we would state as common to the whole group —is the existence of large ship channels on almost every side of the lagoon. *Mille* possesses four large ones—three of them, and one, the largest of all, on the windward side. *Jaluith* has its reef pierced by as many—and much in the same position. While *Majuro* has its channel on the windward side only, and *Ebon* on the leeward, we cannot speak of more from personal observation—though the natives say the other islands possess many channels and in much the same position of those above mentioned.

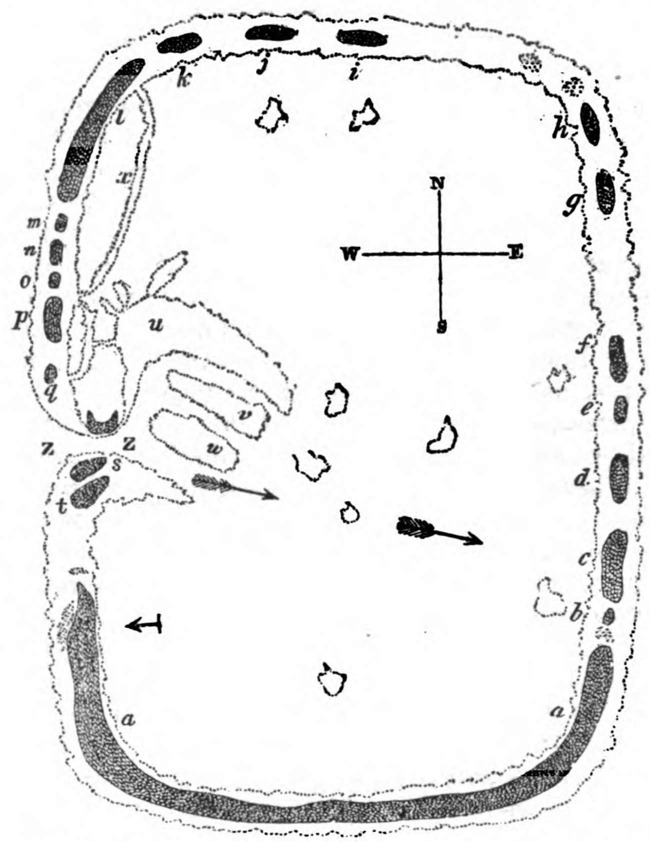
With these remarks upon the general features of the Marshall islands, we proceed to remark upon the atoll of Ebon.

The position of this atoll is 4° 39′ north latitude, 168° 49′ 30″ east longitude. This is the position, from the anchorage of the ship "Morning Star" in the Lagoon. The atoll is the most southern one of the *Ralik* range. It was discovered May 25th, 1824, by Capt. George Ray who named it Boston Island. In 1834 Capt. Covel thought it a new discovery, when it took his name, by which it is often called. The atoll is nearly circular and measures some twenty or twenty-five miles in circumference Except the passage on the west side of the reef, there is no other, not even a boat passage, in the whole circumference of the atoll. The reef however, at full tide, can be crossed by native craft. There is a tradition that once a passage existed, of sufficient capacity to admit ships, on the N.E. side, and that it was destroyed however by some powerful spirit, in his rage, and the present passage opened.

The natives possess also an interesting tradition concerning the existence of *a high island as having once occupied the most of the lagoon.* It is said the tall hills, covered with bread-fruit and cocoanut, reared themselves where now the flats in the lagoon exist. It is said also that what must then have been the barrier reef possessed land, which is now Ebon islet. The present passage is twelve or fourteen fathoms deep, and at the inflowing and outflowing of the tide has necessarily a very strong current, being the only outlet for the whole lagoon—when the waters are lower than the reef. As it flows in, against a strong wind, its presence may be traced quite across the lagoon, from the ripple of the waters and the white caps. The reef-flats near the passage in the lagoon are being covered with sand and other

coral debris—the nucleus of some future islet. The small coral patches in the lagoon are all covered with a few inches of water at low tide.

Ebon is the largest islet on the reef, as shown on the accompanying sketch—and gives name to the whole atoll. Its length from point to point is about eight miles. A singular feature is found upon it, a ledge of coral conglomerate. The map by the sign ↤ presents its position. On the north end of the islet it projects itself free from all soil or sand; and its course as marked, can easily be traced by its repeated outcropping. The land which lies on the sea side is of considerably more recent formation than that on the lagoon side. The difference is very perceptible. The ledge or embankment was formed, no doubt,



a, Ebon; *b*, Dile; *c*, Eniaithok; *d*, Kermkumlab; *e*, Eri Mon; *f*, Remrol; *g*, Koie; *h*, Minlak; *i*, Enear; *j*, Enikaiori; *k*, Riri; *l*, Toko; *m*, Bikri; *n*, Bivilil; *o*, Aneming; *p*, Enilu; *q*, Iu; *s*, Jurith; *t*, Eni-armith; *u*, Worai-thok-thok; *v*, The Komil; *w*, Morelab.

mainly from the wash of the lagoon. This is seen from its lamination sloping that way. It undoubtedly served an important purpose in catching and holding the finer materials thrown up from the lagoon.

At the S.W. bend of the islet the surface is quite uneven,—hills and vales in miniature form and size show themselves. They are formed no doubt by the drift of the sand—blown up into little hillocks. From its elbow round to the N.E. point the islet possesses but little soil. It is however covered with a quite heavy growth of bushes and trees, all possessing a very rich and deep green color—and this is indeed characteristic of the foliage of the whole island. It has none of that sickly yellow, half nourished hue, which we find upon many coral islands—those especially of the Kingsmill group. On Ebon all the growth is beautiful. There is soil and rain enough to nourish well the tropical vegetation.

I have not been able to obtain an exact classification of the plants of this atoll. More than fifty distinct species, however, will be found. We will mention some which enter chiefly into the support of native life. The Artocarpus is represented by some eight or ten varieties, one, the *A. integrifolia*—and the rest *A. incisa*. The *Pandanus odoratissimus* is represented by some twenty varieties. Its fruit enters largely into the native food. It is prepared in large rolls enclosed with its own leaf,—and may be kept for years. The cocoanut (*Coços nucifera*) is represented by some ten varieties distinguished only by the nut. Two varieties of tarro (*Arum esculentum*) is quite plentifully grown. It is raised in large beds prepared somewhat for it. These beds differ from those found on the Kingsmill islands. They are not as there, excavations carefully worked out and good soil prepared and worked in. They seem in a measure to be natural excavations, perhaps the sunken hollows between hillocks. These hollows with some little preparation would answer the purpose:—at least their origin at this day is unknown. If a native be asked concerning them, he invariably refers them to the work of spirits. Around the margin of these arum patches, are grown bananas in quite plentiful crops. And the larger islets have just sufficient to raise oranges and figs, which the missionaries are now growing.

This atoll is the home for a few varieties of birds. But in this feature of the island, the contrast is as wide between the "low coral" island and the "high volcanic" one—as between their natural features. The high islands of Micronesia are largely supplied with the feathery tribe,—but this atoll can claim only a very few birds—and with two or three exceptions these are all water fowl. There are a few Columbidæ, *Carpophaga oceanica*, which manage to elude the keen search of the natives. These birds are occasionally heard cooing away in the tops of some quite isolated bread-fruit tree. A Cuculus gives forth occasionally its sharp whistle—and these, with the addition of another land bird whose species I have not been able to learn—are all the feathery songsters this atoll can claim.

The shores of the reef at low tide, and the bare rocks, are a little enlivened by the brown and white Heron. Small flocks of snipe (*Scolopax*) gather on the sand bars—or single individuals are running along the beach picking up food. An occasional plover (*Charadrius*) is to be seen. Sea swallows (*Sterna stolida* and *Sterna minuta*) are skimming the waters of the lagoon, or resting on the beach. A Booby (*Lula*) now and then is seen sailing over the island. His home is unknown to the natives. His want of caution is clearly seen in the easy way a native will ascend a tree in which the bird is roosting and with a slip-noose capture him. An interesting explanation of the origin of the single variety of the *Cuculus* is given by the natives—so skillful has this bird been in concealing its birth-place. As the natives find it only full grown they say that it is born and nourished in the clouds and falls to the earth of full size.

At least five species of reptiles are found on the atoll. Four are of the Lacertinidæ—and one, Geckotidæ. The Gecko readily domesticates himself, and lives upon the house flies and gnats he finds. The Lacertinidæ find their homes on trees and bushes.

The varieties of insects are interestingly numerous. It might seem as though these atolls, so comparatively recent in their origin would be but feebly represented by any varieties of animal life. But the entomologist will find here not an uninteresting field of study. The most common kind of insect is the parasite *Pediculus*, disgustingly numerous in the heads of natives; a large size Libellula, dragon fly, is quite numerous, and a few of the diurnal and nocturnal Lepidoptera are found. Of ants and mosquitoes and flies there are large swarms. Of the *culex* there is probably a new kind, which might be called *diurnal* culex. They are very small and almost as numerous as those more commonly seen at night. Of Scolopendea—Centipedes—there are many to be found and of rather formidable size—though we rarely hear of their biting any one.

There are several varieties of Spiders. The scorpion, though found on the atoll is small and harmless.

The Crustacea are numerous on land and in the water. We seem to have a great abundance of the Paguridæ—hermit crabs. I have thought they were more numerous on these coral islands than on the volcanic ones.

The Mollusca too are abundant. Some rare specimens are found. The orange cowry is common to some of the Lagoons. Zoophytes also are numerous, as would be supposed in these waters. A valuable and quite abundant sponge is also found in some of the lagoons and the Marshall islands.

It will be noticed, on the reef of this atoll, that besides the islet of *Ebon* there are nineteen others. All of them are much smaller than Ebon, though for their size they are equally fertile. Some of them seem to be veritable fairy-lands—so soft is the

green grass which covers them—and the deep shade of the interlaced bushes and majestically tall bread-fruit trees, throwing out their long sweeping arms like the monarch oak—

—"Who has ruled in the green wood long."

In the growth of some of these islets, we have perhaps some interesting facts connected with the rate of growth of islets or coral reefs. *Bikri* is an islet containing not more than an acre of land. A few Pandanus self-sown from seed washed there by the waters of the lagoon or sea, have taken root. And there are a few bushes,—a variety which I have noticed as growing only on the frontier soil of an islet—soil which is but little more than sand. From the leaves of these bushes and Pandanus, soil is very slowly forming. But *the present age* of the islet is, as stated by a native, who saw it when only a *sand bank* washed by the tides—some *thirty-five years.* He remembers it when a boy as only a sand bank. Now it has a *little* soil and *few bushes.* The islet *Nanming* he describes as once only a sand bank. It is now about the same size and condition as *Bikri.* These facts are not stated of course as definite for determining the rate of growth of coral *islets*—for into such a calculation many other circumstances might enter, such as the position of the reef for catching and holding the washed-up matter, &c. But we may learn from the facts here given, that the growth of land, like the growth of the reef-rock, *is very slow.*

Near the southern extremity of Toko (opposite x on the map) some *thirty-five* years since, there was a passage sufficiently large to let a proa pass over the reef between what was then *two islets.* Now that passage has been filled up, and large bushes grow there. The only tree of any size is the cocoanut and Pandanus, which have been planted. This fact we would state as illustrative of two points—one bearing on the fact we have just referred to—the rate of growth of an islet—and the other, that large islets are made by stringing as it were, together several small ones. It may be questioned whether a large islet, say some two or three miles long, is one continuous production; it was rather formed by several smaller islets becoming attached and the whole in time becoming one large islet. This fact I think can be clearly proved to have been the case with the growth of the islet of Ebon. There are several spots which may be indicated as the *welding* points of small islets. These places are usually narrower, and less overgrown with bushes and trees, and possess a thinner soil than other parts of the whole islet. Then again there are places which are *expanded*, just as if they had been the central nucleii of the islets. These are heavily wooded—have large bread-fruit trees and other trees of apparently an old age, growing upon them. We have reason to believe that all the islets of this atoll will in time be thus united, and thus the

whole reef possess, so far as it goes, one unbroken chaplet of vegetation.

We are now deeply interested in watching the formation of *sand banks* at one or two points. As yet they are shifting about —as the winds and seas prevail for a given time from any quarter; they are as yet covered by high tides. One of these sand banks is between *Eni-armeth* and the northern point of *Ebon.* We may not live to see it, but we believe that this sand bank will yet become *fixed*—will enlarge itself—catch some floating seeds and appropriate them and then there will be another green islet on the reef. This will again expand itself and become the connecting link of Ebon and Eni-armath—thus completing the length of the green band of this Ebon islet on its northern extremity.

Ebon Atoll, Marshall Island, Micronesia, Aug. 16th, 1860.

ART. XXIX.—*On Normal quasi-Vision of the Moving Blood-corpuscles, within the Retina of the Human Eye;* by LEVI REUBEN, M.D.

I. WHILE observing, in the summer of 1857, the apparent changes in the colors of natural bodies, due to transmission of the light from them through various colored media, I looked through a thick plate of deep blue cobalt glass at a clear, bright sky; and upon so doing, I at once noticed an appearance of movement of numerous minute, shining or lucid points, and seemingly in the space a foot or more forward of the eyes. These appearances, as then and often since observed, may be thus described:

1. The earliest impression was that some of the lucid objects showed as mere points, others as bead-like bodies. The bead-form is, however, in this experiment, an illusion, and due to a quick circuitous movement of some of the points.

2. The movements were by regular impulsions, or in jets; and as if, at each jet a new troop of these objects entered suddenly in all parts of the field of view—these moving, as the eye would pronounce, distances varying from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch, and then mainly but not all disappearing just before the next accession.

3. Owing to the quick movement, the effect was as if so many fine lucid lines were rapidly traced; and these were seen at the same moment, throughout the whole of the length already named; or, sometimes, the first formed extremity of the line was observed to vanish first. The lines were apparently not of light or color, but rather of *glistening*, or *lustre.*

4. The jets were *always* sensibly synchronous with the pulsations of the heart; the duration of the lines, from the half to the whole of a pulsation.

5. The movements were in all directions; in lines straight or contorted; generally indicating some divergency from certain points or from along certain lines; and only to be traced after some practice.

6. Thus aided, however, it soon became evident that, as long as the eye was not shifted, the moving objects kept in each part of the field to certain directions, upward along one narrow band, downward or obliquely along another, as if confined to particular channels or paths.

7. The blue glass showed the movements best; but the eyes were not at the time actually directed to the apparent place of the sky, but so that the optic axes met in the space seemingly occupied by the moving objects—not more than four feet from the eyes.

8. With this glass, there was no difficulty in converging the eyes to this space. The objects appeared so distinct, that the vision seemed involuntarily adjusted to them.

8. Yet it was easy to observe that if the eyes were forcibly directed to the sky, or if in any way the direction of the axes to the apparent field of the shining points was lost, the latter were less distinctly perceived; and with media of most colors other than the deep blue, were wholly lost.

The facts can only be reconciled with the hypothesis that the lucid lines are quasi-visible traces of the corpuscles of the blood moving in vessels in the retina; and that they were such, I became convinced during the first observation of them. That the blood can be only that of vessels *in* the retina, becomes certain when we remember—

a.—That these vessels lie in the anterior half-depth of the transparent retina itself.

b.—That the vessels of the choroid coat lie behind the retina or laterally to it, and imbedded in absorbent or black pigment.

c.—That in the eye, subsequent to birth, there are no vessels other than those in the retina, that lie in the course of the cone of rays admitted by the pupil.

Thus, these apparently trifling observations acquire at once both a physiological and a psychological interest, as showing the visual surface and the objects positively impressing it brought, certainly, to their extreme limit of contiguity! I have called this *quasi*-vision, because it does not arise from the presence of any object the rays from which are brought to foci by the crystalline lens; that is, the case is not one of ordinary vision. Yet there is a *positive impression* on the retina, and of just such kind that the mind interprets it into the vision of real, glistening objects in the air. The cause is a *subjective* one (physiologically considered); but the perception (so far as the mind is concerned), is clearly *objective* and *real.* That the phenomenon was not due to

any condition of my own eyes, I determined in my first experiment by desiring several others who were present to look toward the sky through the blue glass: every one (among them a little girl not quite seven years of age) readily discovered and correctly described the general characters of the movement.

With *lighter blues*, the moving points were less distinct and fewer; through a *deep green*, pretty distinct; but faintly and not easily visible through *light green*, or through *orange*. Subsequently I discovered them in tolerable distinctness on directing the unaided eyes toward the sky, or toward cloud-surface not too dark. In all these cases, diffused or daylight was the agent of vision. With all but the *deep blue* or *green*, or a *bluish-green* glass, considerable practice and some effort are requisite in order to *focus* the eye properly, an effect that seems to be secured at the same time with the converging of the optic axes on the proper field, for each hue employed. The greatest difficulty is experienced, as later experiments have shown, with *yellow*, *violet*, and *red* glasses; and with these, consequently, the vision of the lines is very fugitive and uncertain, while their number is small.

In Mackenzie's "Diseases of the Eye," the phenomenon, as witnessed by the unaided vision directed toward the sky, is mentioned as having been noticed at different times by different observers. I am not aware that before the observations I have now detailed, any one had noted the special applicability of colored media, or the superior vividness afforded by use of the cobalt-glass.

Regarding this glass as *dichromatic*—cutting off mainly both extremities and also the rays of the middle of the spectrum transmitted through it, and allowing the passage of two bands chiefly, the one blue, the other a hue of red, I was first led to believe, that, in connection with action of the blood-discs as lenses, dichromatism in the medium furnished an explanation of these phenomena. And, according to Wollaston's analysis of the light reflected from the atmosphere, this is comparable to that of a dichromatic medium, blue and red being also marked elements in it.

The substance of the results now stated, with an exception or two not touching the essential features of the phenomenon or explanation, I presented before the Photographical Society, of this city, June 13th, 1859, and more fully at the meeting following. Not then finding leisure to follow out my intention of offering an account of the subject for the pages of this Journal, I furnished a brief statement to Mr. Seely, and it appeared in the *Journal of Photography* published by him, July 15th, 1859. Professor Rood's observations, in this Journal, September, 1860, recalled the consideration of the subject, especially

as I was already able to add some other and quite as singular aspects of the phenomenon. Even before that date, I had also observed the appearance named in Prof. Rood's second note (Nov. 1860), of the field of view resolving itself "into a mass of small, round, densely packed moving bodies," or rather into several currents of such, moving in different ways; and though without publishing it, had mentioned the fact before the Society above named, giving, however, a different method by which the appearance could be secured.

Prof. Rood considers the lucid traces as *yellowish* in color; and explains them as due to complementary color subjectively arising, in a retina generally impressed with blue rays, along lines in which by passage of yellow blood-discs the blue light is momentarily intercepted. He admits, however, the fact of some appearance, even with the use of a *green*, *red*, *orange*, or *yellow* medium. He deems the indigo and violet rays as mainly influential in the result with the cobalt-glass. Let us recollect, however, that the *yellowness* of the stain of dilute blood is apparent only; the color of one or a few layers of blood-corpuscles must be a *tint* of the same hue possessed by the blood in mass, *i. e.*, of some hue of red. Then, on the hypothesis of complementary color, a *bluish green* glass (the complement of red) should show the phenomenon best; but it does not show it, so far as I have discovered, nearly so distinct as the cobalt-glass. Again, on the same hypothesis, the blood should be of the hue complementary to that of the cobalt-glass, namely, a *yellow* or *greenish-yellow;* but it is in fact red. Furthermore, a violet glass should show the appearance quite distinctly: it really does so only with the greatest difficulty, and then very few points. I have found that, with a yellow or orange glass, the points are few, but marked and bright; and with this medium they are still better seen by the reddish-yellow transmitted light directly following sunset, or at mid-day against whitish and highly illuminated cloud.

Thus I am led to doubt whether the explanation of the appearances can possibly be that they are due to complementary color. The yellowish hue of the lines is not always apparent (to me) with the cobalt-glass; but glistening or brightness always is. With glasses of other hues, it is very doubtful whether the lines show anything like the complementary colors. May not, then, the yellowish hue sometimes appreciable with the deep-blue glass be rather an incident, than in any way essential to the phenomenon? On the other hand, it is quite certain that the various colored media showing these moving points can not all be capable of a dichromatic effect on the transmitted light; so that, while this effect may, when present, operate in intensifying or otherwise modifying the phenemenon, I am led to consider the true cause of the latter as to be sought *in some effect of the*

*blood-corpuscles, acting as lenses, upon the minute pencils of converging and already almost focalized light entering the retina.**

II. In the communications already referred to, certain other facts and principles were stated, which I will briefly recapitulate, taking the liberty to present more clearly some points before implied:

1. Some of the lines did not remain lucid throughout; but before disappearing, along full half their length gave place to a distinct *black* line. This I have repeatedly observed; the change is marked and unmistakable. But owing to the brevity of the whole movement, I at first erred in judging that it was the last-formed half of the line that became black, and that the black portion was the narrower. I have since ascertained that it is the *first-formed half* of the line that becomes black, and either very soon, or just before disappearance; and what is strange, this is uniformly the fact, except that in rare instances, to appearance at least, a line is traced that is black throughout and from the first. The supposed narrowness of the black line also seems to have been an illusion, but one readily accounted for on the principle of the tendency of any distinct luminous impression to extend itself upon the retina.

2. On looking with one eye through a pin-hole in white paper near to a bright gas-flame, and a little obliquely or to one edge of the opening, the bright lines appear; but now the motions are far more rapid and through longer sweeps, resembling very much, except in the brightness of the lines, the play of the eel-like animalcules of a drop of vinegar through the field of the solar microscope. With white paper and the yellow gas-flame, the lines are always of a light bluish-green. Along with and behind the lines, there is usually a mottled appearance, as of patches of bead-like bodies, either stationary, or in apparently slight commotion. Query: appearance of cells forming parts of the anterior layers of the retina?

3. At other times, owing to some slight and uncontrollable shifting of the adjustment of the eye, there appears, in like tint, a wholly different view: the field is now mainly occupied as with a pavement or floor of the small, stationary bead-like bodies; but in the middle of it, always in the very axis of vision at the time, there is a wholly vacant roundish space, apparently if not quite of the size of a three-cent piece. This I have very often witnessed; and the general characters of the appearance are constant.

4. This apparent opening or vacancy through the pavement-covered field of view, having its center always in the axis of vision, at once suggests that the phenomenon is another view of the cells or granules forming certain layers of the retina, but which for some reason are not to be detected over that slightly

* See a note on the Color of single blood globules, in this No., *Scientific Intelligence*—Physics.

elevated portion of the membrane corresponding with the *foramen centrale* and *limbus luteus*, or "yellow spot" of Soemmerring, and which is the seat of most distinct vision. It is difficult, however, to account for the non-appearance of the cells at this point since, anatomically, (beside the fact that the entrance of the artery and the insensible spot of the retina are close to or within its area, on the inner side), the only differences of structure from that of the other parts it presents, are greater tenuity as well as sparseness of nerve-filaments, and the want of the deepest or granular portion of the gray or sensific layer of the retina. Conjectures indeed, may point to the thinness of the retina here as the cause of disappearance of the anterior layer of cells; or, one may even assign this vacancy as the magnified area of the insensible spot.

5. Let it be remembered, further, that though the posterior layers of the retina are of *gray* or vesicular nerve matter, yet the layer is so thin that the color must be quite ineffective; so that the retina through its whole depth is nearly as transparent as water. A consequence is, that this membrane consisting of an expansion of the optic nerve and of ganglionic nerve-substance back of it, is not, as commonly taught, a *screen*, receiving a picture having superficial dimension only; it is, on the contrary, a minute *depth* of impressible though transparent tissue; so that retinal images generally must have *depth*, as well as *area*, and we may say, a real, though in one direction quite limited, solidity of form.

6. Now the red blood-discs, the most numerous variety, moving in the vessels lying directly in front of, and partly in, the impressible portion of the retina, and, which, in the small capillaries are probably separated in most instances so as to advance singly or in very small groups, become comparable to so many minute *lenses*, shot at every pulsation in various directions athwart and in the transparent mass of the membrane. If the capillaries are large enough to admit discs without compression, they remain slightly bi-concave, and supposing them to differ in density from the blood and the retina, their effect must be, if they lie with the concave sides transverse to the rays of light, to overcome part of the convergency given by the crystalline lens, or to cause the minute pencils transmitted by them to diverge. If, however, they present themselves edgewise to the light, *i. e.*, if their concavities are transverse to the paths in which they are advancing, then we may suppose, either, that in the direction vertical to their path they act as convex lenses; or that, while this is the case, certain rays entering at their edges in such part as to strike afterward, from within, either of the surfaces that are outwardly concave, and of course inwardly convex, would undergo total reflection, and so an additional effect of concentrating or massing together the rays would occur, the whole being

brought to a focus more quickly or brighter in itself; and thus, the disc would project this bright pencil just beyond it into the impressible layer, and necessarily carry it along with its own motion. But if the capillary, as is sometimes the case, be too small, so that the red corpuscle becomes wedged, then it has been observed, under other circumstances, to be variously changed in form, usually inclining to globular; and the latter is the form also of the few white corpuscles contained in the blood; so that in these instances the effect of a minute spherical lens is secured or approximated.

7. But, are the corpuscles more dense than the serum and the nervous mass, so that they can act as lenses? It is well known, first, that the specific gravity of healthy blood slightly exceeds that of *brain;* and I shall have to assume that the density of the retinal substance is not essentially different, as its composition and structure are not, from that of brain. But again, in blood whose coagulation is delayed for a few minutes after withdrawal from the veins, the red corpuscles are found rapidly sinking through the liquid, so that the clot thereafter forming is at top yellowish only, or of buff color, and the serum is quite red. The white corpuscles are to a greater extent entangled in the clot. Hence, it must be inferred that at least the red corpuscles have a density distinctly greater than that of the blood, and in all probability, than that of the retinal mass; and this is all that is necessary to show that they *must* act as lenses upon any light which they can transmit.

8. And this brings me to the question, can the *red* blood discs transmit light of any hues, even green or blue? It must be recollected that, in the minute capillary vessels, these discs can no longer advance in masses of several in thickness, but must advance singly, or at most in layers of two or three deep. In such a case, the blood-discs can hardly present a hue deep enough to render them effectively colored, that is, *opaque* to their complementary color. The thickness of two red corpuscles advancing side by side with their longer diameters presented in the direction of entering rays, would not exceed in all about the $\frac{1}{1400}$th of an inch. Now, let us suppose a solution of the same absolute intensity of red as that of the blood, introduced into a wedge-shaped glass of very gradual taper, and in which the film could, near the edge, be brought to a thinness of $\frac{1}{1400}$th of an inch: how much of the spectrum would the red medium at this degree of tenuity cut off? how much of the intensity of a green or blue beam would it destroy? Inappreciably little, it appears to me; and this view is sustained by an experiment named in Prof. Rood's paper. He says: "Yellow solutions, when combined with the blue glass or blue solutions, render the circulation invisible; and it does not re-appear till the yellow solution has been made *so dilute as barely to preserve a yellow tint, and to transmit the spectrum*

almost unaltered." The words which I have here italicized describe exactly what is true in regard to the *red tint* of dilute blood, and of course of the single attenuated streams of blood in the capillaries. The experiment itself disproves the possibility of a real or effective opacity of the blood-discs for green or blue rays. In seeing a blush on the cheek of another person, the eye takes in at once the hue of tens of thousands of closely aggregated capillaries; and here the intensifying effect of concentration is experienced. But in witnessing the movement of the blood in the retina itself, the field is as it were spread out, and near objects thrust apart; and the effect of each pencil so small as to pass through one corpuscle, or two or three in succession, is noted by itself; so that no intensifying of color by mere contiguity can here occur.

9. The explanation I was at first inclined to give of the quasi-visibility of the moving blood-discs, by use of the cobalt-glass or against blue sky or cloud simply, was that of regarding it as an instance of *glistening*, adopting Dové's theory, (as modified by Brewster,) that the perception of glistening or lustre is consequent in some way upon the mental effort to reconcile or combine images formed at slightly differing depths in the retina. The lights employed in the cases now named, or at least in the first two, have prominent a blue and a red pencil. These are of refrangibilities considerably differing. Now, the eye not being perfectly achromatic, the several prismatic colors are focalized at the same time at slightly differing distances from the lens, *i. e.*, at slightly differing depths in the retina. In case of white light, or colors nearly allied, there is so close a sequence of these images, and they overlap, or rather, inter-permeate each other, so nearly, that their hues blend into a single resultant image, white or of the dominant hue, with which the mind occupies itself, the colored borders, or rather *surfaces*, of the image being relatively so slight as to escape perception. But when a dichromatic beam passes to the retina, certain intermediate hues having been mainly eliminated by the medium, there are two images or sets of images that do not so nearly coalesce; an image by the more refrangible rays placed anteriorly, and one by the less refrangible, posteriorly, within the retina. But, bi-concavity of the corpuscles would diverge, say, the blue rays more than the red, producing increased brightness along certain moving points back of the corpuscles, where the two kinds of rays would then come nearer to one focus; or bi-convexity would affect the blue rays again the more distinctly, in the way of increasing the convergency before given by the crystalline lens; and thus the two images might be still more separated, and the effect of glistening, or no sensible effect, should then be anticipated. But, since it is not supposable that yellow, red, and certain other glasses transmit more than one sheaf of closely-allied hues, the supposition of dichromatism fails to be

applicable to these; and being set aside as but an incidental, possibly a modifying circumstance, no probable hypothesis other than that of action of the corpuscles as lenses seems to remain.

10. Another curious phenomenon I early observed, and one for which I have not been able even to imagine a cause. It appears with most of the media used, especially with the darker colors; and usually precedes or attends the vision of the shining traces. It consists in the vision of many very minute but very real black motes or points, that do not sweep off, but are in rapid and considerable agitation, or *swarming*, as it might be termed, over the whole field of view. These appear to be more distant than the lucid points, and equally diffused; and they are seen very constantly.

11. In Professor Rood's second paper, he speaks of the "densely-packed moving bodies" already referred to, as being seen when the light of a salted wick is condensed on the eye, and better when a yellow glass is interposed; and he adds that Professor W. B. Rogers obtains the like appearance by fixing the eye on a bright surface, until that organ is fatigued, or looking through a tube of black paper at a white surface. In my later experiments, made the last summer and autumn, I was surprised at finding this effect produced on closing one eye and laying over the other, open, a paper, white or of any hue not too opaque, and standing with this eye near to a bright gas-flame. The quiet steady flow of minute objects is soon discovered more or less perfectly forming itself in the field of view; it grows more clear, and is seen to consist of many streams in different directions, each keeping its own course; and the appearance suggests streams covered with fine floating ice. But the eye must be rightly focused, looking apparently into the space quite near to it; the appearance easily vanishes, and is hard to recover. It may be observed when a leaf of an ordinary book is laid over the eye, under the circumstances named, or when yellow, greenish, red, or other paper not too dark is used. The color of the objects approaches more or less nearly that of the complement of the medium. The steady flow of the bodies seems to show that they cannot be the same as those seen with the blue glass; and appears to intimate that, while the latter are in the arterial extremities or in the first extremities of the capillaries, so that they still feel the impulsion of the heart, the "floating-ice" objects are in the radicles of the veins, where their propulsion is uniform and their numbers greater.

III. The following notes I select from among such as I have taken down during some of my latest experiments, the past autumn:

a.—With a bright sun; view of the sky about 20° from the sun, through the cobalt glass: When the lucid lines are best seen, and

the eyes adjusted to their place, there is always at the same time a pretty distinct consciousness of the back-ground (sky or cloud) as distant, and as being, directly before the eye, *mottled* with prismatic colors, faint but real; sometimes taking the appearance of mosaic pavement, or of small colored *cirro-cumuli;* so that when the glass is aside, one is disappointed at seeing no cloud, or one of different appearance. In this case, the colors seem mainly *blue* and *red.* The effect I had somewhat unconsciously noticed before; have seen it very positively many times since. Sometimes the appearance is that of fine colored powders mixed; sometimes it is, though faint, quite beautiful, as if the groundwork were of confused rainbows. It is seen more or less distinctly with glasses of nearly all colors. But it vanishes the moment the eyes are directed to the sky, and may reappear when they are again focused to the near field of the moving discs.

b.—Same time, and medium: the lines are mostly lustrous only; very few give even a faint impression of yellow. The spot in the axis of view has least in number; and the eye catches more as it is turning a little to one side. Best seen when the eyes converge to the objects.

c.—Against same sky, through single amber yellow glass: the moving points seen as minute, not colored, few, very bright, quick-moving, and fugitive. Through two thicknesses of the same glass: points fewer, and more fugitive, but quite well defined.

d.—Through dark green formed by combination of yellow and light blue: Looking long and steadily, the eye finds the field of the objects, and so adjusts itself as to see many of them, though only tolerably distinct.

e.—Through grass-green glass: The shining lines readily and distinctly seen; a few quite defined. They show *no tinge of red.*

f.—On another occasion, with the cobalt-glass, against the sky: all the phenomena beautifully made out; the more distant swarming, black points plentiful; the traces of the blood discs numerous and distinct; and a considerable proportion of them turning to black lines just before disappearing,—the black line always at the end first or longest formed, and extending down to a defined extremity, where it *abruptly* changed to, and was continued by, the lucid portion. I could not, however, make out that the black line began at the first-formed extremity, and ran down the course of the whole line; though this may have been so. The black and the bright portions both suddenly and completely disappeared.

g.—Same time, and medium: Found, very evident and certain, a larger channel or spot of ingress where a more numerous, crowded and confused body of the moving objects came at every pulsation, pouring in, *as if from without or beyond the rest, toward*

the eyes; and plainly thus discovered, not as moving in, *but as emerging into the field of view.* This spot seemed, with two eyes, a little to left of the axes of vision; and from it several streams arose. Query: the termination of the *arteria centralis*, or of one of its large branches?

h.—Looking with but one eye, this point of ingress seems very near the axis of vision; and sometimes there is the appearance to be named in the next paragraph.

i.—Looking to the west, clear sky, soon after sunset; through red glass; some few moving points; but chiefly, in the axis of view, a continual influx of a small stream of very small bead-like objects, faint, but real; seeming to move only into the field, and to disappear almost at once through it; not spreading out in it. This appearance I had noticed first of all with a violet glass; and with violet, red, or blue, it was often repeated. By shifting the eye, the movement could be made to occur apparently upward, or to one side; but it seemed to return usually to the downward course. I distinguished this as the *cascade.* The uniform movement seemed to forbid the supposition that this could be the appearance of the corpuscles in the artery; and hence, its explanation is doubtful.

k.—Upon momentarily closing and opening the eyes, there was an appearance of a *rosette-shaped space*, its centre always in the axis of vision, which distinctly and always showed the complementary color of the glass before the eye at the time. This appeared with all glasses; it showed where the axis of vision pierced the sky at the time; and that the cascade was in this axis, the point of jetting in of corpuscles (*g*) in or very near it. This rosette seemed to me to mark the limits of distinct vision on the retina, the portion most impressed by the color of the medium employed. Having observed it, as now named, I could from that time be less distinctly conscious of it, while looking at the moving objects, or other appearances. Thus, through the cobalt-glass, a yellow central spot was really at all times faintly obvious; through green, a reddish spot of like size, and so on.

l.—With glasses showing the moving points faintly, I often succeeded in bringing them out more distinctly for a little while, by having just previously used those of complementary color.

m.—Looking at midday against light cloud: The cascade, small, but very perfect, flowing up, or down, appeared through the cobalt-glass; more faint, through orange, red, and violet. To see any moving traces of the corpuscles, with yellow or red glasses, it was found necessary to compress the eye-ball, as could be done by making the effort to retract it, and to look into a space very near the eyes.

In regard to the facts mentioned in (*k*), it should be added, the traces of the discs were visible both in and around the cen-

tral area of the field, or that which showed the faint complementary color. And the arising of this color after a few moments' use of any of the colored media, seemed to show that, over the most sensitive portion of the retina, the tendency to the perception of the secondary subjective color, or that which follows the impression of a previous and different one, is even stronger than the present impression of any given color, so that the subjective complementary can here displace even the actual or acting color!

IV. The singular results which these observations seems to furnish, then, are the following:

aa.—*Quasi*-vision of moving blood-discs; showing, incidentally, also the places and courses of certain capillaries of the retina.

bb.—Discovery of *some change*, in which the momentarily illuminated trace of the disc, in some cases, and usually at a little distance behind the advancing disc, gives way to *black*.

cc.—*Quasi*-vision, in different ways, of the cells or granules in anterior portion of the retina.

dd.—Discovery, by apparent absence of these, of either the entire seat of most distinct, ordinary vision ("yellow spot"); or else, of the place of the insensible spot, magnified. The latter view doubtful.

ee.—Appearance as of numerous, swarming, black points.

ff.—*Quasi-vision* of numerous small bodies, moving close together, and apparently steadily, in unlike directions, but so that the several streams cover nearly the whole field; as if the contents of many capillaries, or venous radicles, close together.

gg.—Obscure perception of finely mottled colors, at the same time with vision of the moving discs.

hh.—*Quasi*-vision of place of influx of a considerable proportion of the discs into the field of view; suggesting the artery, or a large branch of it.

ii.—*Quasi*-vision of single stream, seen only in a brief course through the field, and seemingly without impulsive movement —the *cascade.*

kk.—Perception of nearly circular, or rosette-shaped area, of subjective color, corresponding with the seat of most distinct vision.

ll.—The actual visibility of this subjective (complementary) color, within and in spite of the generally diffused presence of the opposite color at the time.

V. Among principles incidentally discovered or affirmed in course of the discussion, appear to be the following:

aaa.—That the traces of the moving blood-discs are not invariably, nor necessarily, of a color the complementary of that occupying the surrounding retina at the time.

bbb.—That the blood-corpuscles, single or sparse, as in the retinal capillaries, can transmit, without appreciable diminution of intensity, rays of any color. In this way the coloration of the fine parts of images of pictures, landscapes, etc., on the retina, is not, during our view of the objects, continually interfered with.

ccc.—That moving blood-discs, within the capillaries of the retina, according to their form and position, may affect the light passing through them in various ways, by lens-action or total reflection.

ddd.—That images in the retina are variable in their place, (within the limits constituting, on either hand, myopia or presbyopia), by minute changes of *depth;* and are composed of a series of solid images of as many colors as the light admitted to the eye contains, and more or less perfectly coalescing.

Moreover, as general facts bearing on the explanation of the phenomena now detailed, the following propositions seem to be established:

eee.—That the eye or eyes, in order to discover any of the appearances named, must be *focused* or adjusted for vision of an object at some certain distance. This necessity of focusing the eye explains why, usually, the appearances are so readily lost.

fff.—That this adjustment differs for light of different colors, the implied distance of the object being greater or less. Observations seem to indicate that the distance of the imaginary object is least for the red rays, and less generally for the less refrangible.

ggg.—Hence, when either appearance is seen by merely looking steadily toward a lighted surface, or until the eye is fatigued, it is probable that, involuntarily, the proper focusing or adjustment of the eye takes place.

hhh.—With the single exception, if it be such, of the case of looking steadily at a bright surface, or with the eye fatigued, the light with which any of these phenomena is discovered, is never white or complete light, but always partial, of special colors and refrangibilities.

That is, all the media, or lights, showing these effects, are such as afford rays of not all, but some certain refrangibilities. All these general facts agree with the supposition that the blood-discs become *quasi*-visible by means of their effect as lenses. Although we may not be able to say in what way, *precisely*, each part of the phenomena results, it appears certain that the discs, and in certain other cases the retinal cells, so modify the convergency of rays entering the retina through them, or perhaps in some intances, the divergency of more refrangible rays which have already passed their focus and spread out, (at the very time that red and yellow rays have their focal distance and proper effect),

that the impression of the retina through many of these bodies must be decidedly different from that which it receives or yields around their place. We may say, generally, that the visible corpuscles or cells become so from the fact that in certain ways and degrees they *complement* the effect already impressed on the light by the crystalline lens and the humors of the eye. This view suggests a ready explanation of the circumstance that media of different colors require a convergency of the optic axes toward points at different degrees distant from the eyes; since we must presume that this is one instance of "associated movements," and one in which, accordingly, the mere telescopic adjustment of the place and convexity of the crystalline lens, will be made to correspond, involuntarily and accurately, as in ordinary vision, with the degree of convergency voluntarily or otherwise given to the optic axes.

The change by which certain of the lucid lines are replaced through a part of their length by black, it is difficult to explain. The effect can hardly be that of the accidental or subjective production of black (total absence of impression), succeeding a previous impression of brightness; for, were it such, it should be more general, and follow through the whole length of the bright line. Assuming each line to be not less than twenty times longer than broad, and nearly as broad as the corpuscle could appear, if seen bodily in its place, then the black portion is seen to follow at some distance behind the advancing corpuscle. Is it due to the collapsing wall of the capillary, or to changes in its liquid contents, such as to result, a little way behind the corpuscle, in certain cases, in a brief *total interference* of transmitted rays?—or, such as to produce along an inconsiderable length of the vessel the effect of *total reflection*, excluding momentarily the light from that part of the retina directly behind its place?

Finally, it needs hardly be said that, in order to observe many of the phenomena now considered, much care and patience will be required, and not less an eye so delicately sensible to color that it can appreciate the finest colored points and very faint tints. And the caution must be added, that experiments of this kind can scarcely be protracted very long at any one time, or repeated continually for weeks or months, with no long intervals of rest, without the risk of permanent injury to the delicate organization of the eye.

New York, Jan. 16th, 1861.

NOTE:—*March* 15.—Since the above was written, Sir D. Brewster's paper enumerating "Certain Affections of the Retina" (*Philos. Magazine*, Jan. 1861), has appeared, but containing no allusion to vision of the blood-discs. To the list, this, and certain related phenomena quite as singular, it appears, may now be added.

ART. XXX.—*Upon some Experiments connected with Dove's Theory of Lustre;* by Prof. O. N. ROOD, of Troy.

IN the *Farbenlehre*, p. 177, Prof. Dove writes: "In every case where a surface appears lustrous, there is always a transparent or translucent reflecting stratum of minor intensity, through which we see another body. It is therefore externally reflected light in combination with internally reflected, or dispersed light, whose combined action produces the idea of lustre."

Thus by combining in the stereoscope two projections of a pyramid, one drawn in black lines on a white ground, the other in white lines on black ground, Dove found that the pyramid appeared lustrous as though made of graphite. [To me it recalls rather the idea of highly polished glass.] He found also that a yellow and blue surface when combined in the stereoscope and viewed through a plate of violet glass, produced, in the act of combination, the idea of a polished metal.

Similar to Dove's theory of lustre is that of Prof. Ruete.*

This view of the nature of lustre opens to us the possibility of reproducing by the stereoscopic combination of suitably colored surfaces, the individual lustre and appearance of gold, copper, brass, &c.; it also affords us a means of examining separately the components, which *may produce* the appearances peculiar to each.

1. I combined in the stereoscope on white or on black grounds —a piece of tin-foil one inch square with a piece of yellow paper of the same size. The value of the tint on the chromatic circles of Chevreul was, 1st circle, orange-yellow, No. 4. When the field containing the tin-foil was somewhat shaded by the hand or otherwise, the surface seen in the stereoscope could not be distinguished from gold-leaf. The union of the images took place as readily and the illusion was as strong with persons unaccustomed to the use of the instrument.

2. By combining in the same way tin-foil with orange-tinted paper, (1st circle, orange,) the lustre and appearance of copper is imitated.

3. Tin-foil in the act of combination with Nos. 14 and 15 of the red and black scale imitate bismuth.

4. Tin-foil or silver-foil in the act of combination with ultramarine paper appears scarcely blue, rather black like foliated graphite.

5. Gold-leaf in combination with paper of a tint nearly that of the green of the 1st circle imitated murexide.

6. Gold-leaf in combination with ultramarine paper resembled a surface of graphite.

* *Das Stereoscop;* C. G. Th. Ruete, Leipzig, 1860.

Upon substituting dark grey paper for the tin-foil the same effects in degree were not produced, owing as it seemed to me, to the fact that the well known texture and appearance of the paper forcing itself on the attention, precluded the idea of anything metallic. To remove this difficulty I employed two means.

1. A crumpled sheet of tin-foil was photographed, and from the negative, prints were taken, by the "ammonia-nitrate process," which were toned to the so-called black of the photographers. This furnished dark paper upon whose surface was an accurate drawing of the irregularities characteristic of metallic foil; the surface of the paper was of course wholly without lustre.

(*a*) Upon combining, in black or white fields, a square inch of one of those photographs, with the above-mentioned yellow paper, and shading the photograph a little, a representation of gold was obtained but little inferior to that given by the use of the real tin-foil.

(*b*) This photographic paper in combination with orange paper (1st circle, orange), made an imitation of metallic copper.

(*c*) The ultramarine paper in combination with the photograph of tin-foil gave a striking imitation of foliated graphite. The blue color is perceived much less than would be expected.

2. The surface of a plate of brass 1 inch square was polished, and then rather heavily scratched by a coarse file. Into the scratches a small amount of yellow or white oil paint was rubbed, and upon this prepared surface dark grey or black paper was laid and the whole submitted to the action of a press as in copper-plate printing. By this means a drawing of a scratched metallic surface was transferred to paper. These markings serve also to enable the observer much more easily to direct his attention simultaneously to the two impressions presented.

(*a*) Upon combining dark grey paper (black and white scale, Nos. 18, 19, 20,) prepared in this way with the above-mentioned yellow paper, the appearance of a polished, scratched plate of gold was obtained.

(*b*) When these dark prepared papers were combined with yellow paper colored by gamboge (yellow and black scale, No. 9), the appearance and lustre of brass was obtained.

According to Dove's theory the darker surface in the stereoscope represents the dispersed light, the brighter, that regularly reflected. As the polish of a metallic surface is proportional to the smallness in amount of the light it disperses, we should be led to expect that by varying the shade of the black paper, we should be able to alter the apparent degree of polish of these imitated metallic surfaces.

This is the case: yellow paper, (1st circle, orange-yellow No. 4,) in combination with black (No. 21,) gives the idea of a very

highly polished golden surface; as we descend in the scale, the lustre and resemblance to polished metal regularly diminishes till at grey, No. 8, almost no effect like gold is to be perceived.

On the other hand by diminishing the brightness of the yellow paper, the black tint remaining constant, the idea of a polished golden plate in the shade, or so placed as to reflect the image of some dark object, is produced. Thus we may descend through the circles of Chevreul to the 7th, when by combining the orange-yellow of that circle with No. 21 of the grey scale, the idea of a golden plate much shaded is produced. I constructed tables expressing the effects produced by varying the intensity of the two components, but it is not worth while to introduce them here.

As we are accustomed to see gold tinted variously from nearly a yellow as in gold-leaf, to almost a copper-hue as in some specimens of our American coin, so the tint of the paper placed in the stereoscope, may be varied within certain limits, without greatly affecting the results.

Prof. Helmholtz in his admirable work on physiological optics,* mentions that by a peculiar arrangement he was able to cause the homogenious golden yellow light of the spectrum to appear brown, proving thus that the tint brown is only weak yellow light. These stereoscopic experiments give us on the other hand the means of apparently converting brown into a metallic golden yellow, for many specimens of even brown wrapping paper, when combined in the stereoscope with very black prepared paper, acquire the lustre and appearance of yellow plates in the shade, and reflecting images of dark objects.

In the same manner, and corresponding to the investigations of Helmholtz, I found that the stereoscopic union of black glazed paper with red, (No. 14, red and black scale,) imitated with surprising perfection the appearance of a glazed plate of chocolate.

The chromatic scales of Chevreul furnish us with a ready means of combining in rapid succession in the stereoscope a great number of definite tints; thus by cutting in a card-board two parallel apertures $\frac{3}{10}$ inch broad and one inch long, their distance apart being 2·6 inches, and pasting under one of them black prepared paper, the other can be brought over any desired tint and the effect noted.

1. In this way I found that a pretty good representation of the appearance of slightly tarnished lead was produced by the stereoscopic union of grey No. 18 and No. 4 on the blue-violet and black scale.

2. A somewhat inferior imitation of antimony was given by No. 1 blue and black scale, with gray Nos. 18 to 20, or by using No. 17 blue and black scale with white.

* P. 281. *Physiologische Optik* (*Encyklopädie der Physik*, Leipzig, 1860.)

3. Tarnished zinc surfaces may be imitated by the use of grey No. 5 with No. 18 blue and black scale.

4. Ultramarine paper with some of the lighter violet blues gave an imitation of blue glass. The idea of blue polished glass was also obtained by using in combination with the ultramarine paper No. 1 of the yellow and black scale.

I will mention here that the stereoscopic union of this blue with yellow paper, never induced in my mind the idea of green.

I made some experiments to ascertain how far the *stereoscopic* mixture of two masses of different colored light corresponded to their true mixture by the method of rapid rotation, use being made of the imitations above described. It is however so difficult to compare a varying with a fixed tint that I will not record the results obtained; in many cases a certain moderate amount of agreement in the resultant tints was observed. Brücke found that when a deeply colored yellow glass was held before one eye, a blue cobalt glass before the other, that a landscape viewed through this combination was simply darkened in appearance. I repeated this experiment with similar glasses and obtained a like result; objects appeared darkened, but in their natural colors, though sometimes the blue or yellow tint predominated a little. But when I presented to a *single* eye these two masses of light a very different result was obtained; the plates of glass were attached to a blackened disc opposite suitable perforations, and it was set in rapid rotation; a landscape viewed through it appeared deep purple, though not a trace of this color was to be perceived in the binocular use of these glasses.

When these two glasses were held before the same eye, a landscape viewed through them was very much darkened but scarcely colored.

Sir David Brewster's Theory of Lustre.

Sir David Brewster opposes Dove's theory of lustre, as he has found that when black and white surfaces without drawings are combined in the stereoscope, no lustre is produced. The lustre, then, according to this philosopher is due not to one mass of light passing through another, but to the effort of the eyes to combine the stereoscopic pictures.

Admitting the correctness of Sir David's experiment, Dove has shown that the objection founded on it is without weight—(p. 3, Optical Studies).

In repeating Brewster's experiment I always obtain the *opposite result;* in combining uniform black and white surfaces, without drawings, I always obtain a distinct impression of lustre, like that of the blackened mirror of a polariscope, and in strict accordance with Dove's theory, when the black field is so darkened that *no light* is sent from it to the eye, this lustre vanishes,

and the white paper alone is perceived. This disagreement is not a cause of astonishment when we reflect that de Haldat's original experiment waited nearly half a century for confirmation.

To Brewster's own theory, the simple objection, which has already been made by others, that we daily perceive lustre plainly with one eye, would seem sufficient.

Production of Lustre in Monocular Vision.

I proceed now to describe some experiments where by the action upon a single eye of two masses of light of unequal intensity, the idea of lustre is produced.

1. If a disc of colored card-board, out of which a number of sectors has been removed, be made to rotate rapidly, and an object be viewed through it by a single eye, two masses of light will reach the eye, which apparently proceed from the object; one is reflected from the surface of the disc, the other emanates from the object behind the disc, and passes through the first mass of light. Dark objects viewed in this way assume to me to a small extent an appearance like that of blackened glass. The effect is not at all striking, and would be overlooked by many persons; I therefore prepared paper in a peculiar way so as to imitate distantly the appearance of foliated graphite or crumpled mica.

White smooth drawing paper was rubbed over irregularly with a brush *slightly* moistened with a weak wash of India ink or lampblack; when dry another wash of a deeper hue applied as before, care being taken to leave many small spots untouched. The final wash was laid on with pure black. If the brush be kept nearly dry and passed only lightly over the paper, it is easy to obtain a surface bearing some very distant resemblance to the minerals above mentioned; it is of course without lustre. Similar papers were prepared with red and blue water colors.

When these papers were held behind discs of ultramarine or orange-tinted paper, from which equal alternate sectors had been removed, and which were revolving at such rates that their surfaces seemed uniform, or at lower rates, they often appeared, to a single eye, highly lustrous. This was true of the prepared paper in a *state of rest;* when moved slightly by the hand it glittered strongly. Dark photographs of tin foil held behind a revolving disc of ultramarine paper and viewed by a single eye, assume often to a striking degree the lustre and appearance of foliated graphite.

2. If a piece of this peculiarly blackened paper $\frac{1}{2}$ of an inch square be placed in a blue field, (rather light ultramarine paper,) and be steadily regarded for some minutes by one eye it assumes a red orange-hue and appears suspended over the blue paper

and nearer to the eye than the latter; at the same instant it appears lustrous like crumpled mica. The illusion with me often lasts half a minute in great perfection; this is particularly the case when the eye is not quite accurately focused on the paper.

3. If a sheet of this prepared paper be brightly illuminated by light from a window, and be held so near one eye as to produce indistinct vision, it often apparently becomes highly lustrous. In this case enlarged images of the white and grey points are formed on the retina which overlap, so that again we have two masses of light, one passing through the other.

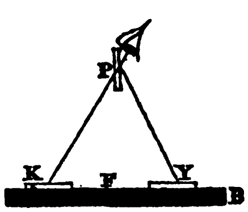
4. If a *roll* of black paper like the above, but coarser in its markings, be brightly illuminated on one side and viewed through deeply colored plates of glass (red, green, blue,) in a few seconds it appears lustrous resembling a roll of polished zinc which has been irregularly and deeply corroded by an acid. Upon removing the glass the surface of the paper appears lustrous for an instant.

5. A sheet of the finer variety of this prepared paper viewed through a large rhomb of calc spar gives often in spots the appearance of lustre, particularly when the head of the observer, or the rhomb, is slightly moved. Some persons compared this to the appearance of water.

It would seem probable that in all cases where two masses of light reach a single eye, one passing through the other, particularly when there is any *perception of their individuality*, that the appearance of more or less lustre is produced, though from habit we often overlook it. Thus Helmholtz remarks* upon the combination of two colored surfaces in monocular vision by means of a simple instrument he figures:—"It is particularly favorable when the drawings, or spots on the two surfaces are made to shift their position. Then we often believe that we see both colors simultaneously in the same place, the one through the other. We have an impression in such cases of seeing objects through a colored vail or reflected from a colored surface."

I found in fact that by placing stereographs consisting of colored paper for one eye and a photographic drawing of tin-foil for the other in this instrument, that lustre could be perceived, particularly with the imitations of copper.

The diagram represents the instrument referred to; it consists of a plate of glass, P, with parallel sides, which is properly supported over a blackened board B. Differently colored papers are placed at K and Y; one is seen through the plate, and the other by reflexion from it. The images are made to overlap and their intensity is regulated by altering their distance from F.



* *Physiologische Optik*, p. 873.

Analogous to this is the observation of Brewster.* Speaking of uniting similar pictures, (patterns on hanging paper,) in binoculor vision, he remarks:—"The surface of it, (the wall) seems slightly curved. It has a *silvery transparent aspect.*" Here the images though of the same intensity, &c., moving with each slight movement of the head induces in the mind the idea of one object seen through another.

In closing I will remark that while many of the experiments above mentioned are easily repeated, others require considerable practice in this kind of observation.

ART. XXXI.—*The Quaternian or Diluvian Period, considered in its relation to the present Epoch;* by F. J. PICTET.

[From the Bibliothèque Universelle (Archives) de Genève, vol, viii, p. 255.]

WHEN in 1844, the first volume (1st edition,) of my elementary treatise on palæontology was printed, I was struck with the impossibility of fixing a precise limit between the Diluvian epoch and the present or modern period. These two periods, it is true, have been considered as distinct in all treatises upon geology; but when I attempted to point out their palæontologic characters, I soon perceived that the zoologic population had not in reality been modified in passing from one to the other, and that they are evidently the uninterrupted continuation of one and the same state of things. This truth appeared to me so evident that I merely indicated the principal arguments which supported it,† without entering into details, and I considered it sufficient, to call the attention of geologists and palæontologists to this point. This has had its influence, and recently, since questions of this nature have taken a new importance by the discoveries relating to human fossils, many geologists have admitted the above conclusions as demonstrated. I would especially mention Mr. Scipio Gras,‡ who is engaged in an important work on the diluvium of the valleys of the Rhone and the Rhine, and also Mr. Lartet,§ who has recently sustained the same opinion in a memoir upon the geological antiquity of the human race in western Europe.

There are however some opponents to these views, especially Mr. Kœchlin Schlumberger,‖ who replying to Mr. Scipio Gras, has called my opinion *a little radical* and has sought to overthrow

* The Stereoscope, p. 91, London, 1856.

† *Traité élémentaire de paléontologie,* note B, 1st edition, tome i, p. 359.

‡ *Bulletin de la Société géologique de France,* 2d Series, tome xv, p. 167.

§ *Bibl. Univ.* (*Archives*), tome viii, p. 193. July, 1860.

‖ *Bulletin de la Société géologique de France,* 2d Series, tome xvi, p. 88. Nov. 21, 18_9.

it. I therefore think it necessary at this time to furnish new proofs and to set forth more clearly those evidences which have decided my own mind, and which I have no doubt will convince the most incredulous.

This question may be considered from two points of view, the geological and the palæontological. I shall only approach the question in the latter aspect, for which my studies have better fitted me, but I ought to remark that we have no example of serious disagreement between palæontology and geology when they are employed to distinguish the several periods of the history of the globe. There is no one of these periods which is not clearly distinguished by the character of its fauna, and no case can be cited where stratigraphy has required a division which palæontology has not confirmed. If we survey the whole series we never find any two consecutive stages in which the zoological population has been identical.

If this is so, the geologists and the palæontologists will be unanimous for uniting these two epochs into one, and for applying to them a common name. I think if I am able to prove, from the standpoint of palæontology, that the two periods are only one, this result ought to be as fully admitted as in analagous cases for anterior epochs.

I know that this opinion is not without question, and that some geologists, whose learning and judgment I highly respect, think that in the condition of the globe and the forces which have existed since the termination of the tertiary period there are sufficient reasons for distinguishing completely the tertiary period from the modern epoch. I shall not discuss this question for which I do not think myself qualified. I will only say that however this may be, it will be impossible for me to assimilate the separation of two periods whose fauna are continued identical from one to the other, to the well determined limits which distinguish geologically and palæontologically all the anterior periods admitted as divisions of the history of the globe. I have elsewhere intimated that these same geologists are singularly embarrassed in regard to the precise point where they ought to establish the division, and that the long series of Quaternary deposits, following the glacial period, which certainly neither commenced nor ends suddenly, will give them very great difficulties.

My object in this communication is simply to demonstrate that between the Diluvian period and the modern epoch there has not been any modification of the fauna having the least relation to the changes which characterize and distinguish other palæontological faunæ. For this purpose I shall consider two distinct points. I shall demonstrate first that *all* actual or modern faunæ have existed from the origin of the Diluvian period. I shall

inquire afterwards what differences exist between the Diluvian fauna and the present fauna and shall show that they consist only in the disappearance of a limited number of the larger species.

I ought however before proceeding to details to notice an objection. Of late years questions relating to the origin of species have been reviewed with renewed ardor, and some persons think that the solution of these questions may have an influence upon the demonstration of the question with which I am now engaged. On the contrary I think the subject with which I am concerned is entirely an independent question. Whether we admit with Lamark or with Mr. Darwin a gradual transformation of beings, or think there is a general law of nature introducing, at certain epochs, new organic forms, or accept the idea of successive creations, we shall in either case be obliged to refer to the same facts in the history of the globe. At the end of a certain number of years or centuries the zoological population of a country is changed and the species are replaced by others. The surface of the globe has been successively occupied by a series of faunæ perfectly distinct; each of these fauna corresponds to a period which it characterizes. Whatever theory may be entertained in regard to the cause of the change, the change itself is not questioned. But all we need to do here, is to show that these organic differences characterize the successive periods, and that there is no such difference between the Diluvian period and the present epoch.

I ought, as I have said, to demonstrate in the first place that all the present faunæ have existed from the commencement of the diluvian period, as well as the last species, of which I shall speak farther on. For this purpose I have recently arranged a complete catalogue of the fauna of European mammifers, and I have inquired which have not been found in the fossil state, and what are those the bones of which have been found buried in the Quaternian or Diluvian beds, with the fossil elephant, *Elephas primigenius* or with the Cavern Bear, *Ursus spelæus.*

Reasoning upon comparable and sufficiently certain facts, I have excluded from this list:

1st, Marine mammifers in view of the difficulty of determining the age of marine Quaternian deposits.

2d, Mammifers of remote regions whose bones are not likely to be found in the more explored and better known diluvian deposits of Central Europe. Thus I have not considered as important either the monkey of Gibraltar, or the small species on the confines of Asiatic Russia, or those which have been recently discovered in Sicily or in Turkey. I have confined myself to those actually living in places where the Quaternian deposits are well known. Besides this, the excellent work of Eichwald

proves the existence of the same state of things in Russia as in England, Belgium, France, Germany or Switzerland.

The following are the principal facts obtained from an analysis of my catalogue, viz:

Almost all the common species of *Cheiroptera* have been found in the Quaternary deposits. I have found, especially those here cited: *Vespertilio:—V. noctula*, *V. pipistrellus*, *V. serotinus*, the *common bat*, the lop eared bat, *Vesp. auritus*, the *fer à cheval*, the *V. discolor*, and the *V. mystacinus*. Is it not extremely probable, not to say evident, that the rare species more recently discovered which are wanting upon this list, are wanting because we have not known how to distinguish their bones or because they have not *yet* been found? What geologist will venture to affirm that, the varieties *V. Leisleri*, *V. Kuhlii*, &c., which only appeared before the species named above, appertain to a more recent fauna.

The same results are furnished by the *Insectivora*.

In these same Quaternary deposits are cited the hedge-hog, the mole and three or four species of the shrew-mouse.

This is all our fauna, for, on account of the reasons mentioned above, I am not able to give any importance to the two species of *Mygale* ('*desmans*'), one from the Pyrenees and the other from Russia, which have not yet been found in the fossil state.

The group *Rodentia* is of difficult determination and we may naturally expect to find some vacancies, but there are none, however, of any importance. We may cite the squirrel, the marmot, the dormouse, the mouse, the hamster (*Crisetus*), the water-rat, the ordinary meadow-mouse, the beaver, the hare, and the rabbit. The only striking vacancy will be that of the porcupine, but Mr. Arcas has fortunately found this also in the caverns of Sicily. There are wanting to our list only some small species of the mouse, the garden dormouse, the muscardin, &c., in regard to which we may make the same reflection, as was suggested by the Cheiroptera. The jerboa, lagomys, &c., are found as fossils in Russia.

The *Carnivora* being in general larger than those animals which represent the preceding groups and being at the same time more easily recognized scarcely present any vacuity.

There have been found the lion, cat, wolf, domestic dog, fox, genet, white bear, brown bear, badger, glutton, martin, beech martin, polecat, ermine, weasel and the otter. There is lacking to this list only the lynx, and it is important to know whether the *Felis engiholensis* of Schmerling, from the caverns of Belgium is not identical with it. I have not supposed that any person could see an indication of a subsequent creation in the absence of some species from excentric regions as the fox of the north, the polecat of Poland, or the *P. boccamela* of the Mediterranean islands.

The only *Pachyderms* of the present fauna yet found in our Quaternary deposits are three, the wild boar, the horse and the ass.

Among *Ruminants* have been enumerated all our present deer, the deer properly so-called, the reindeer, the moose deer, and the roe-buck. The fallow deer is not comprised in this last, but, as is well known, it is not native in Central Europe. There are enumerated also the wild oxen, (the urus and the bison), the chamois, and the goat. The sheep had not been discovered until the last few years, which had probably been more recently imported; however, Mr. Arcas has found in the caverns of Sicily a closely related species, the *mufflon*. Finally, to this series of animals, modern discoveries authorize us to add *man*. All this, as I have said elsewhere,* appears to demonstrate that man has coëxisted with this diluvian fauna and that his history dates probably from the same epoch.

The facts here mentioned are remarkably conclusive, for they prove that all the present fauna of European mammifers have been found as fossils in the Quaternary deposits, except some small species difficult to be determined, the bones of which if preserved, have not yet been recovered. It appears to me evident that these rare exceptions are without value as objections, and that we may boldly declare that: *From the commencement of the Diluvian period to the present day, no species of mammifers has been added to the fauna which then lived in Europe.*

What we have said of mammifers may also be affirmed of birds and reptiles; but upon this part of the subject I shall not enter into details, for these classes are less known and do not furnish results so certain. The examination of a treatise on palæontology is sufficient to show that the existing species are already indicated in the Diluvian deposits.

The terrestrial and fluviatile mollusks are in the same category. Thus with the bones of the *Elephas primigenius* are frequently found buried all our species of Helix, Bulimus, &c., and they show us that for the invertebrata as well as for the vertebrata, all the existing fauna date from the origin of the Diluvian period.

The preceding facts suffice to show that there has been no renewal of the fauna between the Diluvian period and the Modern epoch. We must now consider in what consists the apparent difference which has led most geologists into error. It has been caused by the gradual disappearance of a certain number of species. At the commencement of the Diluvian period the fauna was richer and more complete than it is at present. There lived in Europe at that time not only our present animals but a certain number of species which are now extinct. These latter have gradually disappeared from causes probably in part similar to

* *Bibl. Univ.* (new series), tome vii, p. 364. March, 1860.

those which destroyed one species of ox mentioned by Julius Cæsar, and which destroyed most likely the last representatives of the ure-ox (aurochs) and the elk. The fauna of the eastern continent has been successively impoverished, and as the population and cultivation of the soil increased only a part of the species which once dwelt there remain living.

It is not possible, in the present state of palæontology to prepare a complete and precise catalogue of these extinct species; but it is sufficient for our purpose to sketch the principal features of such a catalogue.

I am embarrassed in regard to the Alluvial deposits of Auvergne, which appear to present characters somewhat exceptional. It is not perfectly demonstrated that the fauna which they enclose has all been contemporaneous with the Quaternary deposits of the greater part of Europe. There are found many species as yet imperfectly known which appear to be extinct and which have not been recovered elsewhere. Such is the *Erinaceus major*, many of the dogs, some polecats, at least three species of deer, the wild goats of Roset, &c. It will probably be necessary to add to them hereafter; but new investigations appear indispensable to make the proper additions with certainty. I have experienced some doubt in regard to many races or species of true Quaternary deposits, indicated as different from those now living, but which have been characterized without doubt by their form and not by appreciable organic characters. It appears to me quite natural that species at the commencement of the Diluvian epoch, finding abundant nourishment in a country where great forests and immense virgin territories replaced our present culture, and being able there to develop in freedom should have frequently had a form a little superior to their existing representatives, which, surrounded by hunters, restrained on every side, lead a more difficult and precarious life. I do not think it possible to give a specific value to slight differences of stature, if all the other characters are identical, and therefore I consider as doubtful many of those species inserted in the catalogues of palæontology. Such are the *Talpa fossilis*, the *Meles Morreni*, the *Lutra antiqua*, the *Sciurus priscus*, the *Arctomys primigenia*, the *Myoxus fossilis*, the *Sus priscus*, &c. Some of these are probably identical with living species. By new researches we shall find that some of these are truly extinct.

But aside from these difficulties and doubts a certain number of species have certainly disappeared which I will briefly enumerate.

In the family of *bears* I consider as lost the great Cavern Bear (*Ursus spelæus*). Their bones characterize well the deposits called Diluvian, or the formations more ancient than the last period of our globe. The *Ursus priscus* is more doubtful

and is probably identical with our black bear. The *Hyenas* appear to have been represented in the ancient epochs by three species which have now disappeared; the hyena of caverns (*H. spelœa*), analogous to the spotted hyena of the Cape of Good Hope, the *Hyena Monspessulana*, of Christol, more similar to the striped hyena, and the *Hyena intermedia*, Marcel de Serres.

In the family of the *felinidœ*, we should add to the wild-cat, the lynx (?) and lion which have disappeared from Europe in the historic period, another species related to the leopard, (*Felis antiqua*).

The numerous order of *Rodents* appear to contain some extinct species more different from the living than those which I have cited above in speaking of differences of form. These are the *Spermophilus superciliosus* of Kaup; the Castor (*Trogontherium*) *Cuviere*, Fischer de Waldheim; the *Lepus priscus* Cuvier, from the breccias of the Mediterranean, and some species of *Lagomys*, &c.

The *Elephant* is one of the most remarkable of the genera among those which have made a part of the ancient fauna of our period. Their bones are, with those of the bear, the most characteristic of these Diluvian strata, since they are abundantly scattered over an immense surface of country. The species best known is the mammoth (*Elephas primigenius*). Of other bones may be mentioned those of the African elephant (*E. Africanus*). The existence of some other species (such as the *E. meridionalis* Nesti), is contested by some anatomists and admitted by others.

The great *Rhinoceros* with valved nostrils (*R. tichorhinus*) less widely diffused than the elephant, and probably also one or two species of the same genus, are striking examples of those races which have disappeared.

It is the same with the *Hippopotami* of which it is thought we may admit the prior existence of many species now extinct (*H. major*, *H. minor*, *H. Pentlandi*, and the hippopotamus of the valley of the river Sômme).

The horse of Pézenas appears to be another species different from the one mentioned above as related to the existing horse.

The genus *Cervus* has been numerous from the commencement of the diluvian epoch, for to the species now living, and which, as I have said, existed then, is to be added the beautiful giant stag of the peat bogs of Ireland (*Cervus euryceros*), the great deer of the Sômme (*Cervus dama giganteus*) the *Cervus martialis*, Gravais, and many species from caverns described by Marcel de Serres.

Among the other species of *ruminants* lost from our fauna, it is necessary to mention the *Antelope Christoli*, M. de Serres, the *Dichotoma*, Gervais, and *Ibex Cebennarum*, Gervais.

I will not add the *Bos primigenius* because it was seen alive by Julius Cæsar.

I have not found among birds or reptiles any species to add with certainty to this list.

We shall find only a few in this category among the terrestrial invertebrata. The marine deposits on the borders of the Mediterranean contain some mollusks of lost species, but their numbers are small compared with species still living.

We thus see, as I have said, that the fauna originating at the period which succeeded the Tertiary epoch has been successively deprived of many remarkable species. This gradual disappearance may have proceeded from many natural causes. First the climate, cooling very much as the formation of great glaciers proves (Glacial period), would not be favorable to any one of them, especially to the great pachyderms, the congeners of which characterize in our day the torrid zone. Still more as I have said elsewhere,* admitting the presence of man from the origin of the latter period, we may, with much probability attribute to him the destruction of a part of the species. If we examine the list which I have given we shall see that, aside from the great pachyderms, it is principally composed of carnivorous animals which man is interested to destroy, and of herbivora which should serve for his nourishment.

Mr. Lartet, in the memoir which I have cited, has furnished a new argument in favor of this hypothesis. He has found marks of the instruments of man upon the bones of many species of this epoch, and in particular upon those of the ox and the goat; these marks being generally deep cuts designed to cause the rupture of the bone, sometimes more superficial wounds as if the object had been to elevate the skin about the base of the horns. This destruction of species is merely like that which daily transpires before our eyes. If new circumstances should cause the laws in regard to the chase to be abolished, and if the great land-owners did not protect some species, it would not be long before all our present deer would be classed among extinct species. They have already disappeared from many countries, and among others from the valley of the Rhone, where the stag and the roe-buck were abundant at the end of the last century.

A curious fact has been cited which seems to confirm what I have said, it is the very limited number of species of small size, or little connected with the wants of man, among those which have disappeared.

Such is the opinion which has been formed in regard to the causes of this extinction. I repeat therefore that these causes can

* *Bibl. Univ.* (new series), tome vii, p. 371, March, 1860.

have no relation to those which acted during the previous periods, for in the renovation of the fauna there has always been a replacing of some species by others.

Here, on the contrary, we merely find extinctions which can no more furnish a basis for distinguishing two periods than could the destruction of the *Bos primigenius* or that of the Dodo.

To complete our knowledge of the history of the Diluvio-modern period, it would be very interesting to ascertain the date of the extinction of each species. Some investigations of this kind have been recently undertaken, principally in England; but observers generally content themselves with stating the relation of bones to the Quaternary epoch without other details. It is important always where it is possible to determine accurately the position and the geological relations of the stratum which encloses them, and sometimes even to indicate whether they are found in the upper or the lower part of the stratum. It is important to examine with great care the bones in the deposits of the glacial epoch, for it is very probable that many species have extended even to that period. By such studies well directed we may obtain more accurate knowledge of this series of extinctions, and I doubt not we shall be more and more convinced that they have been gradual and successive.

ART. XXXII.—*On the Presence of Phosphoric Acid in Igneous Rocks*; by JAMES SCHIEL.

DESCENDING from the Sierra Nevada into the plains of the Sacramento river by the route which leads along Black Bute, we meet west of the Bute with a phosphoritic trachyte crumbling into pieces and covering the surface for many miles. As there is hardly a trace of organic substance to be discovered in the soil from which a luxuriant vegetation is springing, it was to be expected that the rock contained phosphoric acid.* This an analysis showed to be the case. The phosphoric acid is contained in the precipitate obtained by ammonia after a pulverized portion of the rock has been disintegrated by fluohydric acid, heated and dissolved in chlorhydric acid. The washed precipitate is dissolved in a small quantity of hot chlorhydric acid, much tartaric acid and some sulphate of magnesia added, and then the phosphoric acid precipitated with an excess of ammonia; the crystals of the phosphate are forming immediately. The amount of phosphoric acid contained in the rock was thus found to be 0·26 per cent corresponding to 0·78 per cent of phosphate of lime.

* Fownes (*Prize Essay*, 1845) demonstrated the general presence of phosphoric acid in crystalline rocks.—EDS.

ART. XXXIII.—*Ninth Supplement to Dana's Mineralogy;* by GEO. J. BRUSH, Professor of Metallurgy in Yale College.

List of Works, etc.

C. F. RAMMELSBERG: Handbuch der Mineralchemie. 8vo, pp. 1039. Leipzig, 1860.—This work is by no means merely a new edition of Rammelsberg's former "Handwörterbuch des chemischen Theils der Mineralogie." It is entirely rewritten and rearranged, and, as its title indicates, it aims to give the complete history of the chemical properties of each mineral species. It has seventy pages of introductory matter upon the analyses of minerals—the calculation of analyses—a discussion on the value of analyses—the chemical constitution of minerals, including the function of water—heteromorphism, isomorphism, homœomorphism, etc. The whole is arranged according to a convenient chemical classification.

Rammelsberg has done more to give precision to our knowledge of the chemistry of minerals than any other chemist since the time of Berzelius. The present work is one of great value to the mineralogist, the grandest work of the kind ever published—still on careful examination, we are sorry to observe evidences of haste, if not carelessness, in its preparation. It is to be regretted in such a standard book—as this is sure to become—that the author had not given it a little more time and care. This is particularly to be noticed in regard to American minerals:—on page 6 we are told that the native copper of Lake Superior contains 7·29 pr. ct. of silver and 0·03 of mercury; admitting that the specimen examined by Hautefeuille may have contained both silver and mercury, it is unnecessary to offer evidence to the contrary in regard to the thousands of tons which are yearly produced from this region, as shown by the careful investigations of Whitney, Jackson and others.

In many cases where an analyst has made several analyses of one mineral, the author gives the mean result only; this might be well enough, were it not that he very often omits to mention the fact, and compares the results of an extended and careful research, with a single and frequently imperfect analysis, a procedure which certainly has a tendency to create error, and mislead the student who places implicit reliance in this work. Thus, under Danburite, p. 770, examined by Shepard, Erni, and Smith & Brush, we find one analysis by Shepard, one by Erni, and one by Smith & Brush. The natural inference is, that but one analysis was made by each of the two first named, and one by Smith & Brush—had such been the case perhaps Rammelsberg might have been justified in his remark, "that with such differences in results, the nature (composition) of the

mineral remained in doubt." But how does the case stand—and we may be allowed here to remark that there is no doubt as to the identity of the mineral examined by Shepard, Erni, and Smith & Brush; Prof. Shepard recognizes the mineral examined by us as Danburite, and the writer furnished Dr. Erni the specimens on which his analysis was made.—Shepard's analysis gives 5·12 of alkalies and no boric acid, Erni found 14·13 p. c. of alkalies and 10·04 boric acid. Smith and Brush published two complete analyses, and besides showed by direct experiment that the mineral contains no alkalies (this Journal, [2], xvi, 365). No allusion is made to this latter fact in the work before us, but from the simple composition of the mineral, the experiments must be admitted as conclusive in proving the absence of alkalies, and no further discussion of the first two analyses is needed. Other instances of this kind of omission are found under Carrolite, p. 111, Anal. 2 being the mean of three—Cuban, p. 118, Smith's results are overlooked—Hydromagnesite, p. 233, Anal. 2, is the mean of two, four analyses were published—Jenkinsite, the analysis given is the mean of two—Pinite, p. 835, Anal. 7, is the mean of three—Euphyllite, p. 845, the earlier analysis by Crooke is given, while those of Erni and Garret are omitted; Smith and Brush made four analyses of two different varieties finding some 8 pr. ct. of alkalies which had been overlooked by Garrett, Erni and Crooke, one variety analyzed was from the identical specimen examined by Erni and Crooke—Enceladite, p. 888, an early analysis by Hunt is given; Rammelsberg does not seem to be aware that Warwickite and Enceladite are not only identical, but they are the same mineral from the same locality, both containing boric acid.

Rammelsberg proposes to apply the name GIBBSITE to the phosphate of indefinite composition examined by Hermann, notwithstanding this name was first applied by Torrey to a pure *hydrate of alumina*, and the results of the latter have been confirmed by four other chemists. The author gives as his reason, that Silliman, and Smith & Brush found a small amount (0·57–0·67 pr. ct.) of phosphoric acid, consequently showing the presence of a mixture of phosphate and hydrate of alumina. We add, that if this be admitted, the reasoning applies with much more force to the Russian *Hydrargillite* in which Hermann found 1·43 per cent phosphoric acid! The mineral described by Dr. Torrey is a native hydrate of alumina, and Gibbsite having many years precedence, there is no reason for arbitrarily replacing it by the name Hydrargillite. It matters not what Hermann analyzed, it is an indisputable fact that Torrey's Gibbsite is hydrate of alumina, and furthermore such a change of names as our author proposes, is against all usage, and followed out would cause endless confusion in nomenclature. We have

noticed only points in regard to American species; other examples might be quoted to justify our assertion that the work, although of great value, is marred with evidences of haste in its compilation, but we would not overlook the great services its illustrious author has rendered to the science of Mineralogy, of which no better evidence could be quoted than the work we have before us.

Dr. ERNST WEISS: Ueber die krystallographische Entwickelung des Quarzsystems. 4to, pp. 102. Halle, 1860.

ALBRECHT SCHRAUF: Ueber die Krystallformen des Kieselzinkerzes. 8vo, pp. 27, mit 6 Tafeln. Wien, 1860.

ALBRECHT SCHRAUF: Krystallographisch-optische Untersuchungen über die Identität des Wolnyn mit Schwerspath. 8vo, pp. 15, mit 3 Tafeln. Wien, 1860.

H. DAUBER: Ermittelung krystallographischer Constanten und des Grades ihrer Zuverlässigkeit (21. Akanthit). 8vo, pp. 18, mit 5 Tafeln.

C. F. RAMMELSBERG: Ueber Isomorphie und Heteromorphie bei den Singulosilikaten von Monoxyden und Sesquioxyden. Pogg. Ann., cix, 584–94.

J. REINHARD BLUM: Handbuch der Lithologie oder Gesteinlehre. 8vo, pp. 356, mit 50 Figuren. Erlangen, 1860.

W. H. MILLER: Crystallographic Notices, containing observations on the Employment of the Stereographic Projection of the Sphere in Crystallography; on the Measure of the Dihedral Angles of Crystals; on the Cleavages of Rutile; on the doubly-refractive character of Thermophyllite. (*L. E. and D. Phil. Mag.*, [4], xix, 325).

J. P. COOKE: Crystalline Form not necessarily an indication of definite chemical composition; or on the possible Variation of the Constitution of mineral Species independent of the Phenomena of Isomorphism. (*L. E. and D. Phil. Mag.*, [4], xxi, 406, and *this Journal*, xxx, 194.)

E. SÖCHTING: Die Einschlüsse von Mineralien in krystallisirten Mineralien, nebst Betrachtungen über die Entstehung von Mineralien und Gebirgsarten. 8vo, pp. 357. Freiberg, 1860.

DES CLOIZEAUX ET DAMOUR: Examen des propriétés optiques et pyrogénétiques des mineraux connus sous les noms de Gadolinites, Allanites, Orthites, Euxenite, Tyrite, Yttrotantalite et Fergusonite. Ann. de Chim. et de Phys., [3], lix, 357.

A. DELESSE: Recherches sur les Pseudomorphoses, pp. 76. (Extrait des Annales des Mines, xvi, 1860.)

AQUILLA SMITH: A new Pyrognostic Arrangement of the Simple Minerals hitherto found in Ireland. (*Dublin Quar. Jour. Sci.*, No. 1, Jan. 1861.

E. J. CHAPMAN: A popular exposition of the Minerals and Geology of Canada. Under this title, Prof. Chapman has contributed a series of interesting articles to the Canadian Journal of Industry, Science and Art.

A. KENNGOTT: Uebersicht der Resultate Mineralogischer Forschungen in Jahre 1859. 8vo, pp. 212. Leipzig, 1860.—A complete review of the Mineralogical Researches published in 1859, with additional observations and critical notes by Prof. Kenngott.

H. KOPP UND H. WILL: Jahresbericht über die Fortschritte der Chemie, und verwandter Theile anderer Wissenschaften, für 1859. Giessen, 1860. 8vo, pp. 903.—Pages 765 to 820 contain Prof. Kopp's excellent review of the progress of Mineralogy for 1859.

R. HERMANN: Heteromeres Mineral-Systems. (Zweite umgearbeitete Auflage). 4to, pp. 214. Leipzig, 1860.

V. v. ZEPHAROVICH: Ueber die Krystallformen des Epidot. 8vo, pp. 22, mit 2 Tafeln. Wien, 1860.

Descriptions of Species.

ACMITE.—For a memoir on the crystalline form of this mineral by vom Rath, see *Pogg. Ann.*, cxi, 254.

ALBITE [p. 240, VI, VIII].—An interesting variety of albite occurs associated with smoky quartz at Moriah in Essex County, New York. It has a greenish color and a peculiar lustre resembling green diallage. Cleavage very perfect, showing with great distinctness the triclinic striations. G.=2·683 (Brush). Analysis by Mr. Edward H. Twining, Assistant in the Laboratory of the Yale Scientific School:

$\dddot{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	Ign.
67·01	19·42	0·95	0·39	*tr.*	11·47	0·25	0·24=99·73

AKANTHITE [II].—Kenngott considers the mineral from Copiapo described by W. J. Taylor as *stromeyerite* (Suppl. VIII) to be a cupreous variety of *akanthite;* excluding the iron found in the analysis as FeS_2 the remaining sulphids of silver and copper are in the proportions of 4AgS to 1ЄuS (Kenngott, *Uebersicht*, 1859, 115). For a memoir on the crystalline form of *akanthite* see Dauber in Ber. Wien. Akad., xxxix, 685. Dauber describes a new locality of this mineral at the Himmelfurst Mine near Freiberg. Sp. gr. of Freiberg specimens 7·192—7·199, from Joachimsthal 7·246. At Freiberg it is associated with argentite and stephanite. Analyses of *akanthite* by P. Weselsky show it to be identical in chemical composition with argentite. Specimens from Freiberg contained 86·71 silver, 12·70 sulphur; from Joachimsthal, 87·4 silver. AgS requires by theory 87·03 Ag, and 12·97 S.—*Ber. Wien Akad.*, in *Jour. prakt. Chem.*, lxxx, 487.)

ALUMINITE [p. 389, II].—Analyses of *aluminite* by Geist (1) and Dieck (2) from the vicinity of Halle show, according to Heintz, that the specimens may be mixtures of different basic sulphates of alumina, (Kopp, *Jahresbericht*, 1859, 811):

	$\dddot{\text{S}}$	$\overline{\text{Al}}$	$\dddot{\text{Si}}$	$\overline{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
1.	22·18	39·86	1·92	0·40	0·50	0·03	34·91*a* =100·00
2.	15·56	36·54	——	——	——	——	46·89 = 98·99

(*a*) by the difference.

AMMIOLITE [p. 142, II].—F. Field has published (*Quar. Jour. Chem. Soc.*, xii, 27) an extended examination of a *red mercurial mineral* occurring with mercurial tetrahedrite, atacamite, malachite, azurite, limonite, and silicate of manganese and copper at Tambillos near Coquimbo in Chile. It differs materially from the *ammiolite* de-

scribed by Domeykô, especially in regard to the action exerted upon it by acids; still Field considers that it is only a variety of the mineral, derived from the oxydation of a mercurial tetrahedrite. Purified by prolonged digestion in nitric acid, the red powder was found to contain in two different specimens:

	Hg	Sb	S	$\bar{F}e$	$\dot{H}$	$\ddot{S}i$
1.	34·42	14·21	5·43	2·68	4·46	35·50 = 96·70
2.	37·94	15·26	5·98	2·94	4·98	29·78 = 96·80

Dividing the sulphur equally between the mercury and antimony, making the former a simple and the latter a tersulphid, and oxydizing the remainder of each metal, then considering the silica and oxyd of iron as accidental impurities, and deducting the water, we have, according to Field's figures:

	HgO	HgS	SbO_3	SbS_3
I.	31·77	35·53	15·61	16·52 = 99·43
II.	33·36	34·83	14·92	16·77 = 99·88
Mean,	32·56	35·18	15·27	16·64 = 99·65

Field considers that this composition may be represented as a tribasic sulphantimonite of mercury combined with tribasic antimonite of the same metal ($3HgS, SbS_3$) +($3HgO, SbO_3$) equivalent to HgO 32·93, HgS 35·37, SbO_3 17·07, SbS_3 14·63= 100. Or, he suggests further, it may be regarded as an oxysulphid of mercury coupled with an oxysulphid of antimony with the formula $3(2HgO, HgS)+(2SbS_3, SbO_3)$, giving the same percentage and composition. [We do not clearly see the relation between these two formulas, in the first we have three atoms each of HgS and HgO, and one atom each of SbO_3 and SbS_3, and in the second formula 6HgO, 3HgS, $2SbS_3$, and one atom SbO_3. It is evidently impossible for these formulas to give the same percentage composition.—G. J. B.]

Apatite [p. 396, I—VIII].—H. Reinsch has found in the phosphorite of Amberg not only chlorine, fluorine, and iodine, but also bromine.—(Kopp, *Jahresbericht*, 1859, 805.)

Bamlite.—See under *Sillimanite.*

Batrachite.—See *Monticellite.*

Beryl [p. 178, II—V].—Analyses of *beryl* by Hofmeister, (1 and 2) Rosenbach in Silesia, (3) Heubachthale:

		$\ddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{B}}e$	$\ddot{\bar{F}}e$	$\dot{C}a$	$\dot{M}g$
1.	G.=2·65	65·34	21·01	11·32	1·21	0·26	0·12
2.		65·69	20·41	11·60	1·45	0·20	0·11
3.	G.=2·63	66·22	16·36	12·79	1·63	0·78	0·83

—*Jour. prakt. Chem.*, lxxvi, 1, in *Kopp's Jahresbericht*, 1859, 778.

Brucite [p. 133, I, II].—Ingelström has discovered this species at three localities near Filipstad in Wermland (Sweden). It occurs in small rounded masses in limestone. Three analyses gave:

		$\dot{M}g$	$\dot{F}e$	$\dot{H}$
G.=2·40	1.	68·80	3·35	28·80 = 100·95
	2.	66·80	3·60	29·50 = 99·90
	3.	68·51	3·83	27·67 = 100·01

The pure mineral contained no carbonic acid.—(*Kongl. Vetenskaps-Akad. Förhandlingar*, 1858, 187.)

Bucholzite.—See under *Sillimanite.*

Chloritoid [p. 298, V].—T. Sterry Hunt describes the occurrence of *chloritoid* in the crystalline palæozoic schists of Notre Dame Mts. in Canada. At Brome it is found in a fine grained micaceous schist, also at Leeds and other localities in the Notre Dame Mts., it occurs in a similar rock in lamellar masses, rarely more than a quarter inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter, composed of radiating lamellæ, and sometimes making up one-half of the rock. Cleavage of the mineral perfect in one direction, with two less distinct transverse cleavages. Lamellæ often curved, and not easily separable. H. =6. G. =5·13. Color, dark greenish-gray to

black, brilliant black on the surfaces of perfect cleavage; lustre, on cleavage surface vitreous, on cross fracture waxy; streak, greenish gray. Analysis of a specimen from Leeds:

$\dddot{Si}$	$\bar{\ddot{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{H}$
26·30	37·10	25·92	0·93	3·66	6·10=100·01

This variety of chlorotoid has been known among geologists and mineralogists as *phyllite*, and Prof. Hunt shows in his article on this subject (given in this number of this Journal) that Thomson's phyllite from Massachusetts is most probably the same mineral. He further suggests that possibly the *ottrelite* of Haüy may also be a variety of chlorotoid, although this latter suggestion requires further investigation. The abundance of chlorotoid in the schists occurring over wide areas in Canada, and the Green Mountain range, has led Hunt to name these rocks *chlorotoid slate.*

Chrysolite [p. 184, I—IV, VI].—Mr. Edward A. Manice, of the Yale Scientific School, has analyzed the *olivine* found by Prof. O. P. Hubbard in a boulder of coarse basalt at Thetford, Vermont, with the following result:

$\dddot{Si}$	$\dot{Fe}$	$\dot{Mg}$
40·75	9·36	50·28 = 100·36

The oxygen of the silica, iron and magnesia is 21·73 : 2·08 : 20·11 or $\dddot{Si}:\dot{R}$ as 21·73 : 22·19, equal 1 : 1 or $(\dot{Mg}, \dot{Fe})^3\dddot{Si}$.

Grains of green *chrysolite* washed from volcanic-sand found on the sea-shore near Vesuvius, analyzed by Kalle in Rammelsberg's Laboratory (*Pogg. Ann.*, cix, 568) contained $\dddot{Si}$ 40·35, $\dot{Mg}$ 46·70, $\dot{Fe}$ 12·34=99·39. This gives the formula $\dot{Fe}^3\dddot{Si}+7\dot{Mg}^3\dddot{Si}$, corresponding very nearly with the composition of the chrysolite of the Pallas meteorite. Rammelsberg further examined the *white olivine* (Peridote bianco) of Mt. Somma. Occurs in crystals. Sp. gr.=3·243. The pulverized mineral gelatinizes, though with difficulty, with chlorhydric acid. $\dddot{Si}$ 42·41, $\dot{Mg}$ 53·30, $\dot{Fe}$ 2·33=98·04. This is identical with the composition of *boltonite* as analyzed by Smith (Suppl. I) and the writer (Suppl. VII).

Clinochlore [p. 293, I, II, V].—Analyses of *clinochlore* from Achmatowsk by Struve (Kokscharow, *Min. Russlands*, iii, 236, in Kenngott's *Uebersicht*, 1859, 54):

$\dddot{Si}$	$\bar{\ddot{Al}}$	$\bar{\ddot{Fe}}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{H}$
31·64	13·54	5·83	36·20	0·05	12·74
31·52	13·96	6·12	35·68	0·05	12·67

agreeing very closely with the analyses by Craw and v. Kobell of the American and Bavarian mineral.

Copper p. 17, IV, VI].—Hautefeuille has discovered the presence of mercury in a specimen of argentiferous copper from Lake Superior.—(*Compt. Rend.*, xliii, 160, Kenngott, *Uebersicht*, 1859, 108.)

Cronstedite [p. 299].—Damour has reëxamined the *cronstedite* from Przibram, in Bohemia. The mineral is jet-black; opaque; streak dark to olive green; after heating the powdered mineral is perfectly black. H. above 3. G.=3·35. B.B. fuses to a black magnetic mass and with fluxes gives reactions for iron and manganese. Dissolves in acids, and on evaporation yields gelatinous silica. Composition:

$\dddot{Si}$	$\bar{\ddot{Fe}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{H}$
21·39	29·08	33·52	1·01	4·02	9·76

[A determination of the sesquioxyd of iron in this mineral by v. Kobell gave 35·35 on which he recalculated one of Steinmann's analyses (see Min.). We add another analysis by Steinmann which has heretofore been overlooked (Schweig. Jour., xxxii, 69), giving it the amount of sesquioxyd of iron in accordance with Damour's results: $\dddot{Si}$ 22·83, $\bar{\ddot{Fe}}$ 29·08, $\dot{Fe}$ 31·44, $\dot{Mn}$ 3·43, $\dot{Mg}$ 3·25, $\dot{H}$ 10·70=100·73. Damour gives the formula $(\dot{Fe}, \dot{Mn}, \dot{Mg})^6\dddot{Si}+\bar{\ddot{Fe}}^2\dddot{Si}+6\dot{H}$ or $(\dot{R}^3, \bar{\ddot{Fe}})\dddot{Si}+3\dot{H}$.—G.J.B.]

Darwinite.—See *Whitneyite*.

Davyne.—See *Nepheline*.

DIALLOGITE [p. 446, III, VII].—The variety of this mineral called Himbeerspath, occurring at Oberneisen gave E. Hildebrand on analysis:

$\ddot{C}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$
38·94	55·32	2·99	2·07	0·61 = 99·84

DIANITE.—Von Kobell has given this name to a variety of what has heretofore been considered as tantalite, from Tammela in Finland. The specific gravity is 5·5, while that of the tantalite analyzed by Rose, Jacobson, and others varies from 7·38—7·5. The color of the streak blackish-gray; that of the tantalite from Tammela analyzed by Jacobson was dark brownish-red. In other respects *dianite* corresponds perfectly in physical characters with tantalite. Von Kobell, however, finds it to contain a new metallic acid belonging to the same group as tantalic and columbic acids, this he calls *dianic acid*, and the author has also discovered this new acid in euxenite, æschinite and samarskite. For a description of the chemical properties of this acid see this Jour., [2], xxx, 124, and *Bull. der Akad. der Wissenschaften*, March 10, 1860 (Munich).

EPIDOTE [p. 206, II—VII].—R. Hermann has published a continuation of his researches on this species (*Jour. prakt. Chem.*, lxxviii, 295). We quote only the new analyses; the paper is mostly taken up with a discussion of the author's views and objections to the hypotheses advanced by Scheerer.

		$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	Ign.	
1. Bourg d'Oisans,	G. 3·42.	38·00	20·87	15·06	1·90	21·93	—	2·08	— 99·84a
2. Arendal,	G. 3·37.	37·32	22·85	11·56	1·86	22·03	0·77	2·93	— 99·31
3. "	G. 3·49.	36·79	21·24	12·96	5·20	21·27	—	2·86	—100·32
4. Achmatowsk,	G. 3·41.	40·27	20·08	14·22	2·39	21·61	0·53	0·16	— 99·26a
5. Sillböhle,	G. 3·45.	39·67	18·55	14·31	3·25	20·53	1·62	1·23	$\dot{Na}$ 0·52—99·68a
6. Traversella,	G. 3·47.	40·08	16·91	15·93	1·44	19·11	4·97	1·20	— 99·64

(a) with trace $\dot{Mn}$.

For a memoir on the crystalline form of *epidote* see v. Zepharovich in *Ber. Wien Akad.*, xxxiv, 480.

FAUJASITE [p. 323].—A. Knop shows from the optical properties of this mineral that it belongs to the *monometric* and not to the dimetric system, in which it has heretofore been classed by many mineralogists.—(*Ann. Chem. Pharm.*, cxi, 375.)

FELDSPAR [p. 228, I—III].—The glassy feldspar from the trachyte of Drachenfels on the Rhine gave Rammelsberg (*Zeitsch. d. deutschen geolog. Gesellschaft*, xi, 437):

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{K}$	$\dot{Na}$	$\dot{Ca}$	$\dot{Mg}$	Ign.
65·87	18·53	*tr.*	10·32	3·42	0·95	0·39	0·44=99·92

Rammelsberg considers it an isomorphous mixture of a soda and potash orthoclase. For analyses of the feldspar of the Norwegian zircon-syenite, see *Pogg. Ann.*, cviii, 425.

A. Mitscherlich has found baryta as a constituent of the feldspar from Hohenfels, Rieden, Kempenich, Rockeskill and in the *adularia* from St. Gotthard in quantities varying from 0·45 to 2·33 pr. ct.—(*Jour. prakt. Chem.*, lxxxi, 114.

FERGUSONITE [p. 350, III—VIII].—Nordenskiöld (Jour. prakt. Chem., lxxxi, 200,) gives a new analysis of the so-called *fergusonite* from Ytterby:

$\ddot{\ddot{C}}b$	$\ddot{W}$	$\dot{Y}$	$\dot{Ca}$	$\ddot{\bar{U}}$	$\dot{Fe}$	$\dot{\bar{H}}$
46·33	2·85a	39·80	3·15	1·12	0·70	6·44 = 100·39

(a) with SnO_2.

The crystals are tetragonal, have a dark brown color, translucent on the edges H.=4·5–5. Sp. gr., 4·89. This differs very materially from the composition of the Greenland *fergusonite* as analyzed by Hartwall and Weber, that mineral having been found by these analysts to be anhydrous.

FIBROLITE.—See under *Sillimanite*.

FOURNETITE.—See *Tetrahedrite*.

GARNET [p. 194, I—VIII]—T. S. Hunt has discovered an emerald-green *garnet* at Oxford, Canada, in calcareous-spar with millerite. It is massive, granular, or in transparent dodecahedrons resembling *uwarowite*, but is essentially a lime-alumina garnet, with 6 pr. ct. of chromium (this Journal, xxxi, 295).

A bright red manganese-alumina-garnet (spessartine) from Miask, analyzed by Lissenko, contained:

	$\dot{S}$	$\ddot{\text{Al}}$	$\dot{\text{Mn}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$
G.=4·38.	36·30	17·48	30·60	14·32	0·51 = 99·21

(Kokscharow, *Min. Russlands*, Kenngott, *Uebersicht*, 1859, 74.)

Gersdorffite [p. 58, VII, VIII].—A massive variety of this mineral from Pfingstwiese near Ems afforded Bergemann (*Jour. prakt. Chem.*, lxxix, 412):

S	As	Sb	Ni	Co	Fe	Cu
21·51	33·25	0·62	22·79	1·64	16·64	4·01 = 100·46

Excluding the copper it resembles the ferruginous variety of *gersdorffite* from Schladming in Styria analyzed by Pless.

Gibbsite [p. 134, 506, IV].—In noticing Rammelsberg's *Mineralchemie* we have already called attention to his treatment of this species. We here repeat, that American mineralogists, after a careful examination of a large number of specimens from Richmond, have been unable to obtain any such phosphate as described by Hermann. The chemical examinations made independently by four different chemists have confirmed the original result as given by Dr. Torrey, namely, that the mineral is a *hydrate of alumina* and even *purer* than the crystalline *hydrargillite* from the Urals.

We do not pretend to determine what Hermann examined, if it was really a phosphate, it most probably did not come from Richmond. We are, however, somewhat at loss to understand the following statement made in Hermann's paper on Gibbsite (*Jour. prakt. Chem.*, xlvii, 1). He says, that to the solution of the mineral in chlorhydric acid, he added a sufficient amount of tartaric acid to prevent precipitation of the alumina, then ammonia in excess, and finally sulphate of magnesia, without producing any precipitate of phosphate of magnesia and ammonia. This is rather a startling fact for a mineral in which he claims to have found from 11·90 to 37·62 pr. ct. of phosphoric acid. The majority of chemists would certainly conclude that this negative evidence was a sufficiently satisfactory demonstration of the absence of any considerable amount of phosphoric acid in Gibbsite. We also have been unable to obtain any reaction for phosphoric acid in *Gibbsite* by the above method, but we have never experienced any difficulty in detecting it by this means in *Wavellite* or phosphate of alumina.—G. J. B.

Gieseckite.—DesCloizeaux has confirmed the pseudomorphic character of this mineral by an examination of its optical properties.—(2e *Memoire*, 81.)

Gmelinite [p. 321].—Analysis of *gmelinite*, discovered by Gaudry near Pyrgo in the island of Cyprus, by Damour (Bullet. Soc. Géol. (2) xvi, 675, in Jahrb. Min., 1860, 78).

	$\dddot{\text{Si}}$	$\ddot{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
G.= 2·07	46·37	19·55	5·26	5·51	0·78	22·00 = 99·47

Gold [p. 7, I, II, V–VII].—For Dr. Genth's interesting observations on the occurrence of gold, see this Jour. [2], xxviii, 253. This paper has been translated and republished by Prof. Cotta in his "*Gangstudien*." Freiberg, 1860.

Graphite [p. 92, II–IV].—R. Hermann describes *graphite* from Ajaguss, in the Kirghese-Steppes, covering an extent of country equal to 10 square wersts, (1 werst = 3500 feet) occurring in an impure state in clay slate. This graphitic substance had a slaty structure and contained 40·55 graphite, 56·56 earthy matters, 2·80 water. Specific gravity = 2·60.—*Bull. d. Natur. de Moscou*, 1858, 530, Kenngott, *Uebersicht*, 1859, 105.

Harmotome [p. 323, V].—Analyses of *harmotome* from Andreasberg and Strontian, Rammelsberg (*Pogg. Ann.* cx, 624).

	$\dddot{\text{Si}}$	$\ddot{\text{Al}}$	$\dot{\text{Ba}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
1. Andreasberg,	48·49	16·35	20·08	2·07	*tr.*	13·00 = 99·99
2. Strontian,	47·52	16·94	20·25	1·00	1·09	13·45 = 100·25

The oxygen ratio of $\dot{\text{R}}$, $\ddot{\text{Al}}$, $\dddot{\text{Si}}$, $\dot{\text{H}}$, is as 1 : 3 : 10 : 5, taking silica as SiO_2, Rammelsberg gives the formula, ($\dot{\text{Ba}}$, $\dot{\text{K}}$, $\dot{\text{Na}}$) $\dddot{\text{Si}}^2 + \ddot{\text{Al}}\ \dddot{\text{Si}}^3 + 5\dot{\text{H}}$. For the relations between this species and *phillipsite* see the original memoir.

HARRISITE [III, IV].—Dr. Genth informs us that he has now in his collection a specimen of *harrisite* containing a nucleus of unaltered galena; thus substantiating the correctness of his conclusion that *harrisite is copper-glance pseudomorphous of galena.*

HAÜYNE [p. 230].—The blue transparent crystallized haüyne occurring with pyroxene and mica at Monte Somma, examined by Rammelsberg, (*Pogg. Ann.*, cix,) 577, gave in two analyses:

	$\dddot{S}$	$\dddot{S}i$	$\dddot{\bar{A}}l$ (a)	$\dot{C}a$	$\dot{N}a$	$\dot{K}$
G.=2·464 { 1.	11·25	34·04	undet.	10·89	11·47	5·21
G.=2·464 { 2.	undet.	34·08	27·64	10·30	12·11	4·71
Mean,	11·25	34·06	27·64	10·60	11·79	4·96=100·30
Oxygen,	6·75	17·68	12·91	2·89	3·02	0·84

(*a*) with traces of iron.

Subtracting from the oxygen of protoxyds one third of 6·75, or the amount necessary to combine with the $\dddot{S}$ present, we have 4·5 remainder, and the relation of $\dot{R}$, $\dddot{\bar{A}}l$, $\dddot{S}i$ will be as 1 : 3 : 4, or, taking silica as SiO_2, the formula $(\dot{R}+\dddot{\bar{A}}l)\,\dddot{S}i^3$. The oxygen of the protoxyds combined with $\dddot{S}$ is to that combined with $\dddot{S}i$ as 2·5 : 4·5 or 1 : 2, consequently the formula of the mineral may be expressed as $\dot{R}\,\dddot{S}+2(\dot{R}\,\dddot{S}i+\dddot{\bar{A}}l\,\dddot{S}i)$, or $\dot{R}\,\dddot{S}+\dot{R}^2\,\dddot{S}i+\dddot{\bar{A}}l^2\,\dddot{S}i^3$=$\dddot{S}$ 11·10, $\dddot{S}i$ 34·19, $\dddot{\bar{A}}l$ 28·51, $\dot{C}a$ 10·37, $\dot{N}a$ 11·48, $\dot{K}$ 4·35. Rammelsberg calls attention to G. Rose's observation that sodalite, haüyne, and nosean are isomorphous bodies—the silicate $(\dot{R}, \dddot{\bar{A}}l)\dddot{S}i^2$ occurs in all; some haüyne contains chlorine, as well as a certain amount of sodalite. The composition of the three minerals may be expressed as follows:

A. Sodalite = NaCl+*n* $(\dot{R}, \dddot{\bar{A}}l, \dddot{S}i^2)$
B. Haüyne = $\dot{R}\,\dddot{S}$ +*n* $(\dot{R}, \dddot{\bar{A}}l, \dddot{S}i^2)$
C. Nosean = A +*n* B

HEULANDITE [p. 330, IV].—A specimen of crystallized heulandite from Tiegerholm in Iceland analyzed by Rammelsberg (*Pogg. Ann.*, cx, 525) lost 1·91 pr. ct when the air-dried mineral was left for two days over sulphuric acid, and 13·5 additional on ignition, in all 15·48 pr. ct. Composition:

	$\dddot{S}i$	$\dddot{\bar{A}}l$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	$\dot{H}$
	59·63	15·14	6·24	2·35	0·46	15·48=99·30
Oxygen	30·95	7·07	1·78	0·40	0·12	13·74

The ratio of $\dot{R} : \dddot{\bar{A}}l : \dddot{S}i : \dot{H}$ is nearly 1 : 3 : 12 : 6, considering the loss of 1·91 as hygroscopic water, the dry mineral contains $\dddot{S}i$ 60·97, $\dddot{\bar{A}}l$ 15·49, $\dot{C}a$ 6·38, $\dot{K}$ 2·40, $\dot{N}a$ 0·47, $\dot{H}$ 13·57=99·28, giving the oxygen ratio 1 : 3 : 12 : 5, the same as given in the Mineralogy. Rammelsberg, however, considers the former ratio to be more correct, as the zeolites easily part with a portion of water and 1·91 pr. ct. is too much to be called hygroscopic moisture. He gives the formula $(\dot{C}a, \dot{K}, \dot{N}a)^2\,\dddot{S}i^3+\dddot{\bar{A}}l^3\,\dddot{S}i^9+12\dot{H}$, which is the same general formula as stilbite, and in this view these minerals may be regarded as heteromorphous bodies. [It is deserving of notice that German authors use the name *stilbite* for the species which the English and American authorities call *heulandite*, and *desmine* for the mineral we designate as *stilbite.*—G. J. B.]

HJELMITE.—*Nordenskiöld, Jour. prakt. Chem.*, lxxxi, 202.—This name is proposed by Nordenskiöld for a new tantalate found at Kararfshof in Sweden. Crystalline form, undetermined. Color, jet black; lustre, metallic; fracture granular; H.=5·0; G.=5·82; streak, blackish-gray. B.B. decrepitates, falls to pieces and gives off water. In oxydizing flame becomes brown, but does not fuse; with salt of phosphorus dissolves to a bluish-green glass; with borax gives a colorless glass, which becomes opaque on flaming; with soda and charcoal yields metallic spangles. The minerals occur with *pyrophysalite, garnet, gadolinite*, in a rock composed of quartz, orthoclase, albite (?) and mica. Composition:

$\dddot{T}a$	$\ddot{S}n$	$\dot{C}u$	$\dot{C}a$	$\dot{Y}$	$\dot{C}e$	$\dot{U}$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{H}$
62·42	6·56 (a)	0·10	4·26	5·19	1·07 (b)	4·87	8·06	3·32	0·26	3·26=99·37

(*a*) with $\dddot{W}$. (*b*) with $\dot{L}a$ $\dot{D}i$.

HÖRNESITE.—Haidinger has given this name to a new hydrated arseniate of magnesia from the Banat, first observed and recognized as a new species by Dr. Kenngott, on a specimen in the Imperial Mineral Cabinet at Vienna. It occurs in talc-like, stellated, columnar and foliated snow-white pearly masses, in a gray coarsely granular calcite. Crystalline form, monoclinic. The foliæ are transparent, optically bi-axial; lustre on cleavage surface pearly; foliæ, flexible; H.$=$0·5–1·0. G.$=$2·474. According to von Hauer it is insoluble in water, but easily soluble in acids. Composition:

$\dot{\mathrm{M}}\mathrm{g}$	$\ddot{\bar{\mathrm{A}}}\mathrm{s}$	$\dot{\mathrm{H}}$
24·54	46·33	29·07$=$99·94

giving exactly the formula $3\dot{\mathrm{M}}\mathrm{g}\,\dot{\mathrm{H}}+\dot{\mathrm{H}}^5\ddot{\bar{\mathrm{A}}}\mathrm{s}$ or $\dot{\mathrm{M}}\mathrm{g}^3\ddot{\bar{\mathrm{A}}}\mathrm{s}+8\dot{\mathrm{H}}$, analogous to the general formula $\dot{\mathrm{R}}^3\ddot{\bar{\mathrm{A}}}\mathrm{s}+8\dot{\mathrm{H}}$ for erythrine, annabergite, köttigite and symplesite.—(Kenngott, *Uebersicht*, 1859, 17.)

HYDROMAGNESITE [456].—P. Meyer describes an impure variety of hydromagnesite as occurring at Kaiserstuhl in Baden.—(*Ann. der Chem. und Phar.*, cxv, 129.)

KAOLIN [p. 249, V].—Analysis by A. Knop in *Jahrbuch für Mineralogie*, 1859 573:

$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
49·92	35·23	*tr.*	14·85$=$100·00

KERAMOHALITE [p. 382].—Analysis of the so-called *keramohalite* from Maderan by Schweizer (Kenngott, *Uebersicht*, 1859, 12):

$\dddot{\mathrm{S}}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{C}}\mathrm{a}$	Insol.	Cl	$\dot{\mathrm{H}}$[a]
35·96	10·55	3·74	2·51	1·06	0·58	0·22	0·27	1·12	*tr.*	44·26

[a] With some ammmonia.

Appears from Schweizer's experiments to be a mixture of alum, with ($\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{M}}\mathrm{n}$, $\dot{\mathrm{F}}\mathrm{e}$) $\dddot{\mathrm{S}}$ &c. Kenngott shows that Stromeyer's *mangan-magnesia-alum* may be a similar mixture.

LABRADORITE [p, 237, VII, VIII].—A white feldspar from Radauthal in the Harz examined by Rammelsberg contained:

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	Ign.
G.$=$2·817.	51·00	29·51	11·29	0·28	3·14	2·09	2·48$=$99·79

Is essentially *labradorite.*—(*Zeitschr. der deutschen geolog. Gesellsch.*, xi, 101, in Kopp's *Jahresbericht*, 1859, 785.

LAPIS-LAZULI [p. 229, V, VI].—Bergeron has described a variety of lapis-lazuli from Coquimbo, Chili, which phosphoresced strongly on heating.—(*Bull. de la Soc. Géologique*, [2], xvii, 432.)

LEAD [p. 17, III, IV].—C. v. Reichenbach has found native lead in small globules in a variety of basaltic tufa at Rautenberg in northern Moravia.—(*Verhandl. d. k. k. geolog. Reichsanstalt*, in Kopp's *Jahresbericht*, 1859, 769.)

LEUCITE [p. 231, III, V, VI].—Bergemann (*Jour. prakt. Chem.*, lxxx, 418) describes a pseudomorph of *leucite* from Oberwiesenthal which occurs in perfect icositetrahedrons; H.$=$5·5; Sp. gr.$=$2·5616. B.B. acts like orthoclase; partially decomposed by prolonged digestion in chlorhydric acid, in one case 5·94 pr. ct. was taken up. Composition of the whole mass after ignition:

$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{N}}\mathrm{a}$
60·46	22·11	1·98	1·22	13·53	0·52$=$99·82

Loss by ignition 1·22 pr. ct. The anhydrous mineral has the oxygen ratio 1 : 3·1 : 9·4 or nearly that of an oligoclase, in which the soda is replaced by potash.

LIBETHENITE [p. 420, VIII].—This species occurs at the "Mercedes" mine near Coquimbo associated with tagilite and limonite. It has a dark olive-green color and a resinous or waxy surface. Composition, according to F. Field (*Chem. Gazette*, June 15th, 1859.): $\dot{\mathrm{C}}\mathrm{u}$ 66·42, $\ddot{\bar{\mathrm{P}}}$ 29·31, $\dot{\mathrm{H}}$ 3·74

LIEBENERITE.—DesCloizeaux has proved this mineral to be a pseudomorph by an examination of its optical properties. (2e *Memoire*, 80.)

MASCAGNINE.—On page 380 in the Mineralogy the formula for this species should read $NH^4O, SO^3+\dot{H}$ instead of $2\dot{H}$.

MELACONITE [p. 109].—Kenngott (*Uebersicht*, 1859, 97) considers the crystals of this mineral to be pseudomorphs, a view already advocated by Teschmacher and Hayes, who suggested that the crystals might have been altered from the red-oxyd of copper. In opposition to this view, J. D. Whitney (see Min.) has shown that the crystals of cuprite occuring in the same vein with melaconite are uniformally *octohedral*, and in his opinion there is no sufficient reason for considering the crystals pseudomorphs.

MELANHYDRITE.—A new mineral found in a decomposed wacke from Schmelzerthal near Honnef on the Rhine; described by A. Krantz (*Verhandl. d. naturhist, Verein d. Rheinlande u. Westphalens*, xvi, 154). It is amorphous, occurs in irregular nodules, with conchoidal fracture; opaque; color, velvet-black to brownish-black; streak, blackish-brown. Does not fall to pieces when placed in water. In small fragments adheres to the tongue, G. = 1·82. Analysis by Rammelsberg:

$\dddot{Si}$	$\breve{\breve{A}}l$	$\breve{\breve{F}}e$	$\dot{F}e$	$\dot{M}n$	$\dot{M}g$	$\dot{C}a$	$\dot{H}$
41·63	18·72	2·36	7·83	2·51	5·23	1·67	20·71 = 100·66

giving the formula $\dot{R}^3\,\dddot{Si}^2+2\breve{\breve{R}}\,\dddot{Si}+12\dot{H}$ a composition near that of *palagonite*. (Kopp's *Jahresbericht*, 1859, 795.)

MELLITE [p. 475, II, VII].—Kokscharow describes two localities of this mineral in Russia, one at Malöwka in Government Tula, the other near Nertchinsk. The author gives new measurements, and an analysis of the specimens from Malöwka by J. v. Iljenkow.—(*Kokscharow Mat. Min. Russ.*, iii, 217, in Kenngott, *Uebersicht*, 1859, 119.)

	C	$\breve{\breve{A}}l$	$\dot{H}$
G. = 1·597	21·18	14·20	44·16

The amount of carbon corresponds to 42·36 pr. ct. of mellitic acid, so that the results agree very closely with those obtained by Wöhler for specimens from Artern.

MICROCLINE [p. 242, VI, VII].—Scheerer has analyzed the feldspar in which the Norwegian *spreustein* is imbedded, and also the feldspar inclosed in the spreustein crystals, (Pogg., cviii, 430, in Kopp's *Jahresbericht*, 1859, 785). Anal. 1, is the outer, and 2, the enclosed feldspar.

		$\dddot{Si}$	$\breve{\breve{A}}l$	$\breve{\breve{F}}e$	$\dot{C}a$	$\dot{K}$	$\dot{N}a$	Ign.
G. = 2·580	1.	66.03	19.17	0·31	0·20	6·96	6·83	0·21 = 99·71
	2.	65·68	19·53	0·52	0·22	6·93	7·11	0·11 = 100·10

This proves the feldspar matrix and the inclosed nucleus to be identical.

MONROLITE.—See under *Sillimanite*.

MONTICELLITE [p. 184].—An examination of this mineral by Rammelsberg (*Pogg. Ann.*, cix, 569), shows it to be distinct from chrysolite, a fact already indicated by Scacchi. The crystals analyzed had a yellowish-gray color. Sp. gr. 3·119. B.B. rounded only on the edges. The white powder is perfectly soluble in chlorhydric acid, but by heating gelatinizes. Composition;

	$\dddot{Si}$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$
	37·89	34·92	22·04	5·61 = 100·46
Oxygen,	19·67	9·98	8·82	1·24

The oxygen ratio of the silica to the bases is 19·67 : 20·04 or 1 : 1 the same as in chrysolite, but the mineral is an isomorphous mixture of nearly equal parts of a silicate of lime, and silicate of magnesia, a portion of the latter being replaced by protoxyd of iron. Formula $\dot{C}a^3\,\dddot{Si}+(\frac{4}{5}\dot{M}g,\ \frac{1}{5}\dot{F}e)^3\,\dddot{Si} = \dddot{Si}$ 38·13, $\dot{C}a$ 34·65, $\dot{M}g$ 21·65, $\dot{F}e$ 5·57 = 100. Monticellite has the crystalline form, but not the cleavage of chrysolite. The composition is the same as that of Breithaupt's *batrachite*, and the latter must henceforth be classified under monticellite.

NACRITE.—See *Pholerite*.

NATROLITE [p. 327, VI, VII].—I have analyzed the natrolite recently found at Bergen-Hill, New Jersey, in the greenstone taken from the tunnel constructed by the New York and Erie Rail Road Company. Composition:

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
G.= 2·249	47·31	26·77	0·41	15·44	0·85	9·84=100·12

showing it to be a very *pure natrolite* and not *thomsonite* as has been supposed by some mineralogists.—G. J. B.

NEPHELINE [p. 232, II, VIII].—The so-called *davyne* of Monticelli and Covelli placed in the mineralogy under nepheline, has recently been examined by Rammelsberg (*Pogg. Ann.*, cix, 579). The results obtained show davyne to differ from nepheline only in containing carbonate of lime. The crystalline form and cleavage are the same. Analyses:

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$	$\ddot{C}$
1.	38·76	28·10	9·32	15·72	1·10	1·96	5·63 = 99·59
2.	36·81	28·66	10·33	15·85	1·21	—	6·01
3.	36·96	28·31	9·39	—	—	—	6·04

If the carbonic acid and an equivalent amount of lime be subtracted in (1) we have $\dddot{Si}$ 45·41, $\bar{\dddot{Al}}$ 32·92, $\dot{Ca}$ 1·97, $\dot{Na}$ 18·41, $\dot{K}$ 1·29. This is *nepheline*, and *davyne* may be regarded as a compound of carbonate of lime with *nepheline*, analogous to the composition of *cancrinite* as given by G. Rose. Cancrinite differs from davyne in that the amount of lime it contains is not sufficient to saturate the carbonic acid, and a portion of the carbonic acid must be assumed to be combined with soda. If these two minerals contained carbonic acid combined only with lime, and that in an invariable quantity, it could be assumed, as nepheline and carbonate of lime crystallize in the same form, that they might possibly be isomorphous mixtures. But Rammelsberg remarks that the varying amounts of lime and water (in some specs. $\dot{H}$ = 4 pr. ct.), make it more rational to consider both minerals as *nepheline* to a certain extent altered, by the introduction of carbonate of lime—an analogous decomposition being found in the scapolite group.

OTTRELITE.—See *Chlorotoid.*

PARALOGITE.—See *Scapolite.*

PECTOLITE [p. 305, II, III, V—VIII].—Inglestrom has found *pectolite* at Langbans Iron-Mine in Wermland, associated with chlorite and calcite. The mineral resembles asbestos. B.B. gives off water and fuses easily to a white enamel. A partial analysis gave—(*Jour. prakt. Chem.*, lxxxi, 396.)

$\dddot{Si}$	$\dot{Ca}$	$\dot{Na}$ $\dot{K}$(a)	$\dot{Fe}$ $\dot{Mn}$	$\dot{H}$
52·24	33·83	8·48	1·75	3·70

(a) by the loss.

PHILLIPSITE.—For remarks on the formula of, see Rammelsberg's article in *Pogg. Ann.*, cx, 622.

PHOLERITE [p. 251, VIII].—Mr. Richard Müller of Carlsruhe has communicated to Prof. Dana the following analysis of the so-called *nacrite* (Nakrit) recently found at the *Einigkeit* mine in Freiberg, Saxony. It occurs as a white, scaly crystalline aggregate in seams in gneiss and is associated with galena. Composition:

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{H}$
	46·74	39·48	14·06
Oxygen,	24·92	18·45	12·97

The ratio of $\dddot{Si}$, $\bar{\dddot{Al}}$, $\dot{H}$, is as 4 : 3 : 2 and Müller gives the formula $\bar{\dddot{Al}}^3\,\dddot{Si}^4+6\dot{H}$ or $\bar{\dddot{Al}}, \dddot{Si}^2+2\dot{H}$. This is exactly the formula and composition found by Dr. Genth for the *pholerite* of Tamaqua, Pa. (this Jour., [2], xxviii, 251, and Suppl. VIII). Knop gives an analysis of an impure *pholerite* from Niederrabenstein in Jahrbuch für Mineralogie, 1859, 545.

PHOSPHOCHALCITE [p. 425, II, VI—VIII].—F. Field describes crystals from a mine near Coquimbo which have a turquoise blue-color and consist of

$\dot{Cu}$	$\bar{\dddot{P}}$	$\dot{Ca}$	Ca Cl	$\dot{H}$
20·93	37·69	36·64	2·33	2·32 = 99·91

This he represents by the formula $2(\dot{Cu}^6, \bar{\dddot{P}}\,\dot{H}^3)+10(\dot{Ca}^3, \bar{\dddot{P}})+\mathrm{Ca\,Cl}$ or 2 atoms phosphocalcite, 10 atoms of tribasic phosphate of lime, and 1 atom of chlorid of cal-

cium. It occurs with a hydrous apatite, and it may be questionable whether the mineral is of uniform composition, there is however no doubt that the copper exists in the mineral as phosphate.—(*Chem. Gazette*, June 15th, 1859.)

PHYLLITE.—See *Chlorotoid.*

PINITOID; A. Knop (*Jahrb. Min.*, 1859, 558).—This new name has been given to a constituent of a rock occurring near Chemnitz, in Saxony. The rock consisted according to Knop, of quartz 58·06, mica 6·19, feldspar 8·44 and pinitoid 25·73=98·42. The *pinitoid* was dissolved out from the other species by sulphuric acid. It is a micro-crystalline mineral of a clayey and compact character. Color leek oil and grayish-green sometimes passing into white and red. G.=2·788, H.=2·5. It is a secondary product, and frequently occurs as pseudomorph after feldspar in decomposed porphyry. Composition:

$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{Mg}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$
47·77	32·65	8·94	5·86	1·50	0·49	*tr*	4·19 = 101·40

This corresponds so closely to some of the analyses of the Saxon *pinite*, that it is to be regretted the author has embarrassed the science with a new name for a species already overloaded with synonyms.

PISANITE, *Kenngott, Uebersicht*, 1859, 10. This name is given by Kenngott to a cupreous variety of copperas from Turkey, analyzed by Pisani, noticed in the VIII Suppl. under *copperas.*

POLYCRASE [p. 357].—This species has been found by E. Zschau in the syenite of the Plauenische-Grund near Dresden, (Letter from Prof. Geinitz).

PROUSTITE [p. 78].—Analysis of *proustite* from Chile by F. Field (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	As	S
64·88	15·12	19·81 = 99·81

$3AgS, AsS_3$.

PYRARGYRITE [p. 77, IV].—Dark-red silver from Chile gave F. Field on analysis (*Quar. Jour. Chem. Soc.*, xii, 12):

Ag	Sb	S
59·01	53·16	17·45 = 99·62

$3AgS, SbS_3$.

PYROXENE [p. 158, I, II, V—VIII].—Crystals of pyroxene from Vesuvian lava of the eruption in 1631, analyzed by Wedding (*Kopp's Jahresbericht*, 1859, 780).

$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Mn}}$
48·86	8·63	2·73	4·54	20·62	14·01	*tr.* = 99·39

For observations on crystals of pyroxene from Warwick by vom Rath, see *Pogg. Ann.*, cxi, 263.

RUTILE [p. 120, V, VII].—Observations on the crystalline form of, see Kokscharow in Bull. Imp. Acad., St. Petersburg, i, 229. For Haidinger's remarks on the crystals of rutile from Graves' Mountain, Wien Akad. Abhand. January 5, 1860.

SARCOLITE [p. 200, II, VI).—Rammelsberg (*Pogg. Ann.* cix, 570) has made a complete chemical and crystallographic examination of this mineral, confirming the results given by Scacchi. Occurs in transparent dimetric octahedrons; color, reddish white; sp. gr. =2·932. Gelatinizes with chlorhydric acid. B.B. fuses to a white enamel.

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{Fl}}$
1.	39·79	22·15	31·59	3·30	1·20	*tr.* = 98·03
2.	40·78	21·07	——	——	——	
3.	40·97	21·30	33·14	——	——	
Mean,	40·54	21·54	32·36	3·30	1·20	*tr.* = 98·91
Oxygen,	21·03	10·34	9·24	0·84	0·20	

The oxygen ratio of $\dot{\text{R}} : \dddot{\bar{\text{Al}}} : \dddot{\text{Si}}$ is as 1 : 1 : 2, the same as in garnet. Rammelsberg writes the formula $3(\dot{\text{Ca}}, \dot{\text{Na}}, \dot{\text{K}})^2\dddot{\text{Si}}+\dddot{\bar{\text{Al}}}^2\dddot{\text{Si}}^3$. This analysis agrees with the results obtained by Scacchi (Min. p. 200). Sarcolite differs from humboldtilite in containing no magnesia, but the two minerals are nearly related and both have the same crystalline form.

SCAPOLITE [p. 201, I, II, V].—An examination of *paralogite* by Kokscharow proves it to be dimetric, confirming its identity with scapolite, as previously suggested by Kenngott (*Bull. Imp. Acad. de St. Petersbourg*, i, 229).

SERPENTINE [p. 282, I–VIII].—C. W. Hultmark has analyzed the *chrysotilé* and *serpentine* from Sala, Sweden (*Jour. prakt. Chem.*, lxxix, 378).

		$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$	$\ddot{\mathrm{C}}$
Chrysotile,	1.	41·03	1·43	1·25	42·31	*tr.*	13·72	*tr.*= 99·74
Serpentine,	2.	41·02	1·84	1·81	42·21	*tr.*	12·91	0·48=100·27

SILLIMANITE [p. 265, 513].—An optical examination of this mineral by DesCloizeaux has finally set at rest the question as to its relations to *kyanite*. Its optical properties prove it to be monoclinic, while kyanite is triclinic. With this species DesCloizeaux classes *fibrolite*, *bucholzite*, *xenolite*, *wörthite*, *bamlite* and *monrolite*. These all have the same optical properties, and they also differ from kyanite in density. A new analysis of sillimanite by Damour gave: (*Ann. des Mines* [5], xvi, 219.)

$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$
39·06	59·53	1·42	0·28=100·28

from which DesCloizeaux concludes that the composition of sillimanite is $\overline{\dddot{\mathrm{Al}}}^4\dddot{\mathrm{Si}}^3$, while kyanite is $\overline{\dddot{\mathrm{Al}}}^3\dddot{\mathrm{Si}}^2$. To establish this point fully, will require an accurate examination, not only of the varieties of sillimanite, but also of fibrolite and other allied minerals.

SILVER [p. 15, III, IV].—A pseudomorph of *silver* after stephanite is described by G. vom Rath in *Pogg. Ann.*, cxi, 266.

SODALITE [p. 229, II, VI. VIII].—Two varieties of *sodalite* from Monte Somma have been analyzed by Rammelsberg (*Pogg. Ann.*, cix, 574). 1. *Colorless sodalite*, crystallizes in regular dodecahedrons and is associated with augite and mica; sp. gr. 2·136. 2. *Green sodalite*, is more rare, crystallizes in dodecahedrons with cubic planes, occurs in limestone with idocrase and nepheline. The analyses, calculating the chlorine as combined with sodium give:

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Na}}$	Cl	Na
1.	38·12	31·68	18·49	6·69	4·37=99.35
2.	38·76	34·62	21·18	2·55	1·67=98·78

The oxygen of the soda, alumina and silica in (1.) is 4·74 : 14·79 : 19·79; in (2.) 5·43 : 16·17 : 20·12, or very nearly 1 : 3 : 4 in both varieties.

Rammelsberg considers it as $(\dot{\mathrm{Na}}+\overline{\dddot{\mathrm{Al}}})\dddot{\mathrm{Si}}^2$ combined with varying portions of chlorid of sodium. In (1.) the amount of sodium combined with the chlorine is equal to one-third the soda existing as silicate, while in (2.) it is but one-ninth. The formulas given for the two varieties are:

1. $\mathrm{NaCl}+3(\dot{\mathrm{Na}}\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}})=2\mathrm{NaCl}+3(\dot{\mathrm{Na}}^2\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}^2\dddot{\mathrm{Si}}^3)$
2. $\mathrm{NaCl}+9(\dot{\mathrm{Na}}\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}})=2\mathrm{NaCl}+9(\dot{\mathrm{Na}}^3\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}^2\dddot{\mathrm{Si}}^3)$

The author argues that this double silicate is isomorphous with NaCl, as these substances combined in various proportions still have the same crystalline form. No. 1 has the same composition as the green sodalite from Greenland, and the blue variety from Brevig, Litchfield, Salem, and the Ilmen Mts.

Decomposed sodalite.—In the same memoir Rammelsberg also gives an analysis of a variety of weathered sodalite from Greenland. It occurs in opaque greenish dodecahedrons with black hornblende (arfvedsonite?). Decomposed by acids.

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{Ca}}$	Cl	$\dot{\mathrm{H}}$ (loss).
	43·20	32·54	11·42	3·00	*tr.*	9·84
Oxygen	22·43	15·19	2·92	0·86		8·75

The ratio for $\dot{\mathrm{R}}$, $\overline{\dddot{\mathrm{Al}}}$, $\dddot{\mathrm{Si}}$, $\dot{\mathrm{H}}$, is nearly 1 : 4 : 6 : 2, for which the author gives the formula $3\dot{\mathrm{R}}\dddot{\mathrm{Si}}+2\overline{\dddot{\mathrm{Al}}}^2\dddot{\mathrm{Si}}^3+6\mathrm{aq}$, but it may be questionable whether this substance is homogeneous, and worthy of being considered as a distinct chemical compound.

STILPNOMELANE [p. 287, III, IV].—L. J. Inglestrōm (Jour. prakt. Chem., lxxxi, 397), has found *stilpnomelane* at Pen Mine in the Parish of Nordmark in Sweden, occurs in veins sometimes four inches in thickness; radiated, foliated, sometimes in globular masses intermingled with actinolite. Composition:

$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Fe}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
45·61	37·70	5·00	3·00	9·14 = 100·45

[The author gives no proof that all the iron exists as protoxyd, thus leaving the composition of the mineral in doubt; we have previously drawn attention to the importance of ascertaining the oxydation of the iron in this mineral, when discussing its relations to the American *chalcodite* (this Jour. [2], xxv, 198).—G. J. B.]

TAGILITE [p. 426].—F. Field has analyzed *tagilite* from the "Mercedes" mine near Coquimbo, Chili. It is a beautiful fibrous variety, and occurs in considerable quantity associated with limonite. (Chem. Gazette, June 15th, 1859.)

$\dot{\mathrm{Cu}}$	$\dddot{\mathrm{P}}$	$\dot{\mathrm{H}}$
61·70	27·42	10·25 = 99·37

This gives the formula $\dot{\mathrm{C}}\mathrm{u}^4\,\dddot{\mathrm{P}} + 3\dot{\mathrm{H}}$, the same as obtained by Hermann for the original specimens from Nischne Tagilsk.

TALC [p. 275, V].—A peculiar indurated variety of this species occurs in veins in gneiss at Bristol, Connecticut. It has a dark leek green color, and a greasy lustre and feel. H. = 2. G. = 2·82. Analysis by Dr. H. H. Lummis in the Laboratory of the Yale Scientific School:

$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
64·00	4·75	27·47	4·30

TETRADYMITE [p. 21, 512, I, VII].—Analysis of tetradymite from Cumberland England, by Rammelsberg (Min. Chemie, p. 4):

Bi	Te	S
84·33	6·73	6·43 = 97·49

equal to $\mathrm{Bi}^4 + \mathrm{Te} + \mathrm{S}^4$.

The telluret of bismuth from Field's Gold Mine near Dahlonega analyzed by Dr. C. T. Jackson, (this Jour. [2], xxvii, 39), and pronounced by him to be identical in composition with the Brazilian *bornite*, has bean reëxamined by Dr. F. A. Genth with the following result: (*Mining Magazine*, (2), i, 358.)

		Bi	Te	Cu	Fe	Au. quartz, &c.	Se
G. = 7·941	1.	50·83(a)	48·22	0·06	0·17	0·72	*tr.* = 100·00
	2.	50·97	47·25	0·06	0·25	0.80	*tr.* = 99·33

(a) by the difference.

This agrees with the composition obtained by Dr. Genth for the *tetradymite* from Fluvanna Co., Virginia, and differs entirely from *bornite*, and the results of Dr. Jackson. This difference is explained by the fact that the methods of analysis employed by Dr. Jackson were unreliable, and consequently gave erroneous results; attention has been called to this point in an editorial notice in Erdmann's Journal für praktische Chemie, lxxix, 507, also in a similar notice in the Réperetoire de Chemie Pure, ii, 288, as well as by Dr. Genth (loc. cit.). Dr. Jackson has replied to Dr. Genth's criticisms (*Mining Magazine*, [2], i, 466) but inasmuch as no new facts or analyses are given, we must consider the Dahlonega *tetradymite* as essentially the same as that from Fluvanna Co., Virginia, and *not identical* with the Brazilian *bornite*.—G. J. B. [Since the above was written Dr. Genth has replied to Dr. Jackson, (*Mining Mag.*, (2), ii, 64, January,) showing the inaccuracies of the methods used by the latter.]

TETRAHEDRITE [p. 82, I, II, V].—*Ch. Mène* has described a new variety of tetrahedrite from Ardillats (Dept. de Rhône) France, which he calls *fournetite*. It occurs with galena in a quartzose porphyry. No physical characters, except density, are given. Its composition in three analyses was:

		Cu	Pb	S	Fe	As	Sb	Quartz.
1.	G. = 4·319	24·50	9·90	19·00	2·50	6·60	18·20	16·70
2.	G. = 4·305	23·00	8·70	16·70	2·10	5·80	16·00	27·40
3.	G. = 4·320	26·80	10·50	19·20	2·50	6·70	18·70	15·20

rejecting the quartz gangue, the mean of the analyses gives Cu 32·00, Pb 12·00, S 23·00, Fe 3·00, As 8·00, Sb 22·0.—(*Comptes Rendus*, li, 463).

TRIPLITE [p. 408].—Bergemann describes a new locality for this mineral at Peilau in Silesia (*Jour. prakt. Chem.*, lxxix, 415). In thin splinters translucent. Color dark-brown almost black; streak, light liver-brown. H.=4. Sp. gr. 3·617. The surface of the mineral is frequently coated with oxyd of manganese. The pure mineral dissolves in chlorhydric acid without evolution of chlorine. Composition:

$\overline{\text{P}}$	$\dot{\text{F}}\text{e}$	$\dot{\text{M}}\text{n}$	$\overline{\text{F}}\text{e}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$	$\dot{\text{N}}\text{a}$	$\dddot{\text{S}}\text{i}$	Ign.
32·76	31·72	30·83	1·55	1·19	0·32	0·41	0·23	1·28=100·29

giving the formula $\dot{\text{M}}\text{n}^4\,\overline{\text{P}}+\dot{\text{F}}\text{e}^4\,\overline{\text{P}}$.

URANOPHANE.—*Websky* (*Zeitschc. d. deutsch. geol. Gesellschaft*, xi, 384, Kenngott, *Uebersicht*, 1859, 193), has given a more complete notice of this mineral before described by him (loc. cit., v, 427). It occurs in the copper mines at Kupferberg in Silesia. The mineral appears to be compact and amorphous, but the microscope reveals small acicular crystals which in druses have the form of flat hexagonal prisms. Color of crystals honey-yellow, of the compact variety siskin-green. Hardness somewhat less than 3. G.=2·78, specimen not perfectly pure. Lustre, vitreous to pearly. B.B. in glass tube gives reactions for water (alkaline), tellurium, selenium; in forceps, fuses with difficulty to a black glass, and gives a faint green color to the flame; on charcoal, becomes black, gives a reaction for selenium, antimony and bismuth; with fluxes, gives reactions for silica and uranium. Decomposed by both sulphuric and chlorhydric acids. Two analyses by Grundmann, (1) honey-yellow to siskin-green variety, (2) faint grayish green variety containing pitchblende as impurity:

	$\dot{\text{H}}$	$\dddot{\text{S}}\text{i}$	$\overline{\text{A}}\text{l}$	$\overline{\text{U}}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$	$\dot{\text{K}}$	$\overline{\text{P}}$	Bi	Sb	Te	Fe	Pb	Cu[b]	Ag	S
1.	14·11	15·81	5·65	49·84	4·69	1·35	1·71	0·12	1·73	1·46	0·43	0·57	0·29	0·21	0·11	1·66=99·74
2.	12·19	11·19	2·80	54·23[a]	3·58	1·19	0·80	0·05	1·77	1·86	0·22	0·89	0·38	5·24	?	3·96=100·34

(a) with some $\dot{\text{U}}\,\overline{\text{U}}$. (b) with some $\dot{\text{C}}\text{u}$.

after subtracting from (1) 0·81 chalcolite, 0·13 argentite, 0·23 covelline, 0·33 galena, 1·21 iron-pyrites, 1·19 tetradymite, 1·29 bismuth-glance, 0·02 sulphur, there remains, according to Websky, for the composition of *uranophane:*

$\dot{\text{H}}$	$\dddot{\text{S}}\text{i}$	$\overline{\text{A}}\text{l}$	$\overline{\text{U}}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$	$\dot{\text{K}}$
13·99	15·81	5·61	49·33	4·69	1·35	1·71

for which he gives the formula $3(\dot{\text{R}}^3\dddot{\text{S}}\text{i})+5(\overline{\text{R}}^2\dddot{\text{S}}\text{i})+36\dot{\text{H}}$.

[The mineral is undoubtedly a secondary product, and one may reasonably question its constancy of composition, and its right to be considered a distinct species.—G. J. B.]

VERMICULITE? [p. 292].—In the year 1851 Mr. W. W. Jefferis found near the clinochlore locality at Westchester, Pennsylvania, a peculiar bronzy yellow micaceous mineral, which on examination proved to be optically-biaxial with a low angle, resembling phlogopite, and it has for some years been circulated among mineralogists as a variety of phlogopite.

An examination of this substance made by Prof. J. Lawrence Smith and myself in 1853, showed its composition to be near that of chlorite, and it was considered by us to be a weathered chlorite, although our results were never published. My attention has since been called to this mineral by its peculiar pyrognostic properties. When a fragment of it is heated in the flame of a spirit lamp even without the aid of the blowpipe, it exfoliates in a most remarkable manner swelling up to fifty or more times its original size, thus very much resembling *thermophyllite* and *vermiculite* and altogether differing from *chlorite* or *mica.*

According to a statement communicated to me by Mr. Jefferis, it occurs in a vein in the serpentine rocks fifty yards south of the clinochlore locality; the vein is about two feet wide, and is composed of plates and crystals thrown together in the most irregular manner. The crystals are so soft and friable when first taken out, that it is difficult to handle them, they will scarcely bear their own weight. It is also found in crystals in the soil near the locality. The crystals are six-sided prisms, with a mica-like structure and a perfect basal cleavage, they vary form one to three inches in diameter and are sometimes an inch or more in thickness. Mr. Jefferis has

one large crystal measuring six by four inches. The mineral is optically biaxial; laminæ less flexible than chlorite, almost brittle; color, brownish-yellow, light-yellow by transmitted light. Specific gravity of the air-dried mineral about 2·30. Hardness, between gypsum and common salt. B.B. in forceps exfoliates and becomes pearly white and opaque, and on prolonged heating fuses to a dark gray mass. In closed tube exfoliates, frequently bursting the heated tube, and gives off water which reacts alkaline. With the fluxes gives reactions for silica and iron. Decomposed by chlorhydric acid. The air-dried mineral lost 4·19 pr. ct. in weight by drying in a sulphuric acid desiccator, and 3·74 pr. ct. additional when dried at 100° C.: heated in an air-bath to 220° C. it lost 4·17 pr. ct., but between 220° and 300° C. the loss was scarcely appreciable, and maintained at the latter temperature for half an hour it suffered no farther diminution in weight; at a full red-heat over a blast-lamp it lost 5·85 pr. ct., making in all 17·95 pr. ct. Assuming the amount lost by drying over sulphuric acid to have been hygroscopic moisture, we have 13·76 pr. ct. of water contained in the mineral. It is difficult to determine what amount of water should be included as essential, but it is perhaps safest to take the mineral as dried over sulphuric acid. For analysis the mineral was decomposed by fusion with carbonate of soda—the state of oxydation of the iron was determined by dissolving a separate portion in chlorhydric acid in an atmosphere of carbonic acid, and subsequent titration with permanganate of potash—the alkalies were estimated by Smith's method. Composition:

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
37·10	17·57	10·54	1·26	0·56	19·65	0·43	*tr.*	13·76 = 100·87

Other analyses made in 1853 by Prof. Smith and myself gave similar results. The iron in the mineral has undoubtedly been partially oxydized by weathering, many of the crystals are impure from infiltration of foreign matter between the laminæ and they are quite friable from exposure. It belongs to the chlorite section of magnesian hydrous silicates and in view of its pyrognostic properties we refer it with a query to vermiculite, which its chemical composition approximates. The great difficulty of obtaining pure vermiculite in sufficient quantity for analysis has thus far prevented me from reëxamining it, in fact I have delayed publishing my results on the Weschester mineral for more than two years, hoping thereby to be able to determine more fully its relations to this species. The oxygen ratio for the $\dddot{\mathrm{Si}}$, $\dddot{\bar{\mathrm{R}}}$, $\dot{\mathrm{R}}$, H as calculated from the analysis is as 19·89 : 11·36 : 8·36 : 11·23 or 7 : 4 : 3 : 4 equal to $8\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+4\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}+12\dot{\mathrm{H}}$ or the more general expression $(\dot{\mathrm{R}}^3\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}+\mathrm{Aq}$. The mineral is however so much altered by exposure, and so liable to impurities from infiltration of foreign matter, that it is very unsafe to draw any conclusion from the analyses, further than to refer it in a general way to the chlorite group near chlorite and vermiculite. The chief object in mentioning it here, is to call attention to its remarkable pyrognostic properties. The exfoliation in heating is not due to the escape of hygroscopic moisture, as it does not take place to any considerable degree until the mineral is exposed to a temperature above 300° C.—G. J. B.

WATER [p. 110, VIII].—L. Dufour has found the density of ice 0° C., to be 0·9175. —(*Comptes Rendus*, l, 1039.)

WHITNEYITE [VII].—D. Forbes has described (*L. E. & D. Phil. Mag.*, (4), xx, 423,) under the name *darwinite*, an arsenid of copper which is identical in physical and chemical properties with Genth's *whitneyite.* It is stated to occur in veins near Potrero Grande near Copiapo, Chile. It is massive, without cleavage, rather brittle, but may be distinctly impressed by the hammer; fracture uneven; lustre metallic; color of freshly-fractured surface dark silver-grey, on exposure dirty bronze-yellow; streak metalic, silver-grey; opaque. H.=3.5. G.=8·64. B.B. gives reactions for copper and arsenic with trace of silver. Composition:

	1.	2.	3.	4.
Cu	88·35	88·07	88·11	88·02
Ag	0·38	0·24	0·08	0·42
As	11·27	11·69	11·81	11·56

[These results leave no doubt as to the identity of the mineral with *whitneyite* (see Sup. VIII,) for which Genth obtained Cu 88·07, As 11·81, Ag and insol. 0·33 =100·21.—G. J. B.]

WÖHLERITE.—For a memior on the crystalline form and optical properties of, see DesCloizeaux, (*Ann. des Mines* [5], xvi, 229).

WOLFRAM [p. 351, I—III, IV, VIII].—An interesting variety of this species is described by Dr. F. A. Genth (*Mining Magazine*, [2], i, 359). It occurs associated with quartz and mica, about 1½ miles from St. Francis River, St. Francis Co., Missouri; it is said to have been found in considerable quantities. Crystalline and cleavable parallel to the brachydiagonal; color, brownish-black; lustre, sub-metallic; streak, cinnamon-brown; Sp. gr. 6·67. Analyses by G. J. Pöpplein; (1) Decomposed by fusion with carbonate of soda, (2) by chlorhydric acid:

	$\dddot{W}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	
1.	75·29	5·69	19·02	1·13	=101·13
2.	75·52	undet.	19·73	undet.	———

The oxygen ratio of $\dddot{W}$, $\dot{F}e$, $\dot{M}n$, $\dot{C}a$, is 15·56 : 1·26 : 4·28 : 0·32, giving a new type of this mineral with the formula $\dot{F}e\,\dddot{W}+4\dot{M}n\,\dddot{W}$.

XENOLITE.—See under *Sillimanite*.

YTTROTANTALITE [p. 359, IV].—In a memoir (*Jour. prakt. Chem.*, lxxxi, 193) on the chemical and crystallographic characters of the tantalates and columbates of yttria, Nordenskiöld gives a new analysis of *yttrotantalite* and points out the isomorphism of this mineral with polymignite and polycrase. The new analysis of the black variety of yttrotantalite gave:

$\overline{\overline{T}}a$	$\dddot{W}$	$\dot{Y}t$	$\dot{C}a$	$\dot{F}e$	$\dot{U}$	$\dot{C}u$	$\dot{H}$
56·56	3·87	19·56	4·27	8·90	0·82	*tr.*	6·68=100·66

ZINC [VII].—According to G. Ulrich, native *zinc* has been found in basalt near Victoria in Australia. The specimen found weighed 4¼ ounces, and was incrusted with smithsonite and aragonite, and a trace of cobalt bloom. Another locality is described by L. Becker as occurring in the gold washings of the Mitta river.—(*Kenngott, Uebersicht*, 1859, 108.)

ZINCITE [p. 110, II, III].—W. P. Blake has described and analyzed a very pure variety of this mineral from Franklin. It has a much brighter and clearer color than the ordinary red-oxyd, more nearly resembling crocoisite or realgar. It is transparent, orange yellow, has a distinct cleavage parallel to the vertical axis of a hexagonal prism, and also a basal cleavage, the latter being free from the black layers which separate the laminæ of the ordinary oxyd. In the specimen described there were several slender hexagonal prisms partially imbedded in a white enamel-like crust, the result of the weathering of the mass. H.=4—4·5. G.=5·684 (at 60°F.) Composition: (*Mining Magazine*, (2), ii, 94.)

$\dot{Z}n$	$\dot{M}n$	Ign.
99·47	0·68	·23=100·38

ZOISITE [p. 211, IV].—DesCloizeaux has shown from the optical properties of this mineral that it is distinct from epidote, the former belonging to the monoclinic, while the latter has the triclinic form. (*Ann. des Mines*, [5], xvi, 219].

ZWIESELITE [p. 399].—The probable identity of this mineral with triplite is pointed out by Kenngott (*Uebersicht*, 1859, 80). The author shows that the identity of crystalline form and other physical properties is further supported by the similarity of chemical composition, and that *zwieselite* is but a variety of *triplite*.

ERRATA.

Pages 358, 359, 365, 366. For *chlorotoid* read *chloritoid*.

Page 360. The analysis of *diallogite* by Hildenbrand is from the Annalen der Chemie und Pharmacie, cxiv, 348.

ART. XXXIV.—*On the conversion of certain Conglomerates into Talcose and Micaceous Schists and Gneiss, by the Elongation, Flattening and Metamorphosis of the Pebbles and the Cement;* by Prof. EDWARD HITCHCOCK.

IT will be seen by the statements below that the subject of this paper arrested my attention nearly thirty years since. But it was only within two or three years that I began to realize its importance and resume its investigation in connection with my youngest son, Charles H. Hitchcock. Nor was it till within a few weeks that the locality, which more than any other shows the completion of the metamorphic process for which we contend, was discovered. If we are not mistaken, these facts have an important bearing upon that most difficult subject of geology—*Metamorphism*,—for they show most conclusively the plastic condition of this conglomerate and the associated schists and gneiss, subsequent to their original consolidation. Other strong arguments do, indeed, lead to the same conclusion: such as the change exhibited by the Azoic rocks from a mechanical to a crystalline condition, the complicated foldings and contortions of these rocks, the remarkable curvatures of the veins of granitic rocks; and the existence of superinduced structures, such as no mere mechanical forces could have produced. But I pass by all these proofs now, and present only that from the changes in certain conglomerates.

So far as my knowledge of geological literature extends, the facts, and some of the conclusions presented below, are mainly new; and this is the chief reason why I offer them to this Journal. Professor Sedgwick has, indeed, described joints that "have actually cut through the pebbles of quartzite and other hard masses which enter into the composition of the conglomerates." (*British Palæozoic Rocks*, p. xxxvi, *Introduction.*) But he does not describe the pebbles as elongated, and he calls the joints "*mechanical*," which epithet I am confident he would not apply to the joint in the Rhode Island or Vermont conglomerates. The same thing is described by Jukes, in his Manual of Geology, more fully. He also notices as an effect of cleavage, the "distortion of fossils and other small bodies imbedded in the rocks, lengthening and pulling them in the direction of the cleavage and contracting them in the opposite direction." These facts, first noticed by Prof. John Phillips, have been used by Messrs. Sharpe, Sorby, and others, to sustain the hypothesis of the production of cleavage by "the action of great forces of compression, squeezing the particles of rock in one direction and lengthening them in the opposite." The facts which are presented in this paper harmonize with these views and lead to generalizations still higher, especially to the position so ably defended by Scrope, Beaumont,

Scheerer and Hunt, of the plastic condition of all the deep seated rocks since their original consolidation, and showing us how rocks mechanically formed are sometimes converted into schists, with entire changes of mineral character. Admitting these conclusions, the whole subject of metamorphism becomes comparatively easy and full of interest. This affords no small relief to one, who, like myself, has been for years perplexed and confounded in studying the highly metamorphic rocks of the Green mountains.

Doubtless many geologists will demur at my conclusions, as I should have done without visiting the localities. I can ask them only to suspend their judgment till they have seen the rocks which I describe, especially those at Newport and at Plymouth. If they shall then propose any more rational theory, I hope I shall be willing and thankful to receive it.

With these preliminary remarks I proceed to the details. We give them as proving and illustrating the following statement, and essentially in the language we shall use in our Report on the Geology of Vermont.

We have found striking examples where the pebbles of conglomerates have been elongated and flattened so as at length to be converted into the silicious laminæ of the schists and gneiss and the cement into mica, talc, and feldspar.

In a Report on the Geology of Massachusetts made by me in the year 1833 a singular conglomerate was described near Newport R. I.:—"composed of elongated rounded nodules of quartz rock passing into mica slate, with a cement of Talcose slate, the nodules varying from the size of a pigeon's egg, to four and even six feet in their longest diameter, and so arranged that their longest diameters are uniformally parallel to one another, lying in a north and south direction. The conglomerate is divided by fissures running east and west vertical to the horizon, and parallel to one another from ten to twenty feet apart. These fissures divide the thick masses of comglomerate so perfectly that they seem as if cut through by the sword of some Titan. The nodules through which the fissure passes, are divided very neatly and the parts present even surfaces, so as to give the rock a quite peculiar aspect."

These facts were repeated in the subsequent Reports upon Massachusetts in 1835 and 1841. But it was not until we found an analagous conglomerate along nearly the whole western side of the Green mountains that the special bearing of the facts above mentioned upon metamorphism occurred to us. Myself and son then (1859) visited Newport to get a clearer view of the facts in the hope that they would help us better to unravel the intricacies of the Vermont conglomerates. That same year I read before the Amer. Assoc. for Adv. of Sci., a paper on the subject, as it was developed at Newport and at E. Wallingford, where an interesting locality had been discovered by Mr. Hager, another of my assistants in the geological survey of Vermont.

In 1860 my son brought the subject again before the Association for Adv. of Sci. But it was not until after that time that the last link in the argument was supplied by a visit to a locality in Plymouth, Vt., which was also discovered by A. D. Hager. We will now try to state the facts and conclusions as they have been gradually worked out by us. If any should wish to verify our statements and see the force of our reasoning, we advise them to visit the different localities in the order in which we describe them. For the processes began at Newport, seem to be carried to the conclusion in Vermont.

Perhaps the best exposure of the Rhode Island conglomerate is at the well known 'Purgatory,' two and a half miles east of Newport, and within the limits of Middletown. According to the paper of C. H. Hitchcock read before the Am. Association in Aug., 1860, the belt of conglomerate commences a little south of Purgatory, is a mile wide with interstratified belts of slates, and extends N. 30° E. probably as far as Sandy Point, in Portsmouth some 5½ miles. It shows several folds, is underlaid by a gritty schist or sandstone, and itself underlies the coal measures.

"It is a coarse conglomerate, composed of elongated and flattened pebbles, from the smallest size, to bowlders nearly 12 feet long, cemented by a meagre amount of talcose schist, or sandstone," with numerous small disseminated crystals of magnetite. The pebbles are mostly a fine-grained, or compact quartz rock, which when partly decomposed appears like sandstone; not unfrequently the pebbles seem to pass into an imperfect mica schist, and show lamination. A few of them are gneiss, and probably granite, and occasionally hornblende rock. In their shortest diameter they rarely exceed a foot, while in length, one, two, and three feet are very common, and a few may be seen from 4 to 6, and one, at least, is as long as 12 feet. The following facts as to the pebbles, are of the most interest:

1. They are often very much elongated in the direction of the strike; 2. They are flattened, but not so strikingly as they are elongated; 3. They are indented often deeply by one being pressed into another; 4. They are sometimes a good deal bent, occasionally in two directions; 5. They are cut across by parallel joints or fissures, varying in distance from each other from one or two inches to many feet. The most distinct of these joints, which are a rod or two apart; are perpendicular to the horizon, and nearly at right angles to the strike, and make a clean cut from top to bottom of hills 30 or 40 feet high. Abrading agencies have often removed the rock on one side of these joints, or between two of them, so as to leave walls of pebbles smoothly cut in two; the whole appearing like a pile of wood neatly sawed. Acres of such walls may be seen in the vicinity of 'Purgatory.' Often the surface of the pebbles thus cut through is not only perfectly even, but smooth and seemingly polished. Yet the two parts

of the pebbles thus cut off, perfectly correspond, and one part has never been made to slip over the other. In some minor joints single pebbles are not entirely cut off, but are sometimes drawn out of their beds at one end where the rock is separated, and remain projecting above the cleared surface. These joints do not always extend through the whole rock.

We should be glad to introduce here many sketches of specimens illustrating these statements. But one or two must suffice:—

Fig. 1 will give some idea of an elongated pebble from Newport, which is 10 inches long and 3 inches across its broadest part.

1.

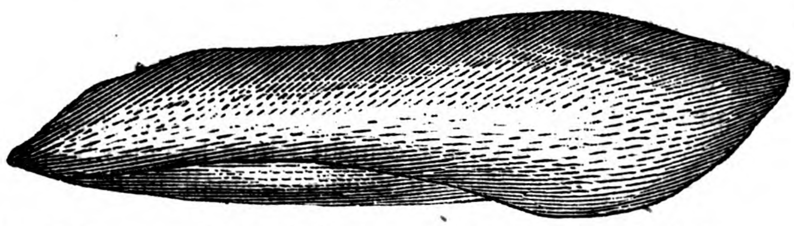
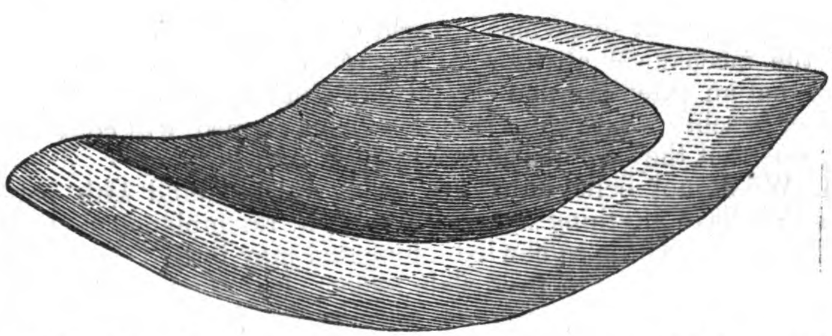


Fig. 2 shows a pebble 8 inches long with a deep indentation.

2.



Perhaps I ought to add that sometimes the elongated pebbles partially or wholly lose their rounded form at the ends, and begin to assume a foliated or schistose aspect, and to be somewhat blended with the talcose or micaceous cement. This though not general, is frequently the case.

From these facts we could hardly avoid drawing the following conclusions:

1. This rock was once a conglomerate of the usual character, except in the great abundance of the pebbles, and it has subsequently experienced great metamorphoses making the cement crystalline and schistose, and elongating and flattening the pebbles. 2. The pebbles must have been in a state more or less plastic, when they are elongated, flattened and bent. If their shape has been thus altered, their plasticity must of course be

admitted; for the attempt to change their present form would result only in fracture and comminution. The degree of plasticity, however must have varied considerably; for some of them are scarcely flattened or elongated at all—and as has been stated, some are not cut off by the joints.

The neat and clean manner in which the pebbles have been generally severed by the joints, implies plasticity.

For though occasionally we meet with one that has a somewhat uneven surface, as if mechanically broken, such cases are rare. Whatever may be our theory of the agency that has formed the joints, the conviction is forced upon every observer that the materials must have been in a soft state after their original consolidation. There is no evidence that the opposite walls have slid upon one another at all, as the opposite parts of the pebbles coincide. It seems as if a huge saw or cleaver had done the work.

These proofs of plasticity apply essentially, though less forcibly to the micaceous and talcose cement which has also been cut across by these joints. Though generally small in quantity it sometimes forms layers of considerable thickness interstratified with the pebbles.

Some have imagined that the elongated, flattened, bent, and indented pebbles of this conglomerate may have been worn into their present shape and brought into a parallel arrangement by the mechanical attrition of waves and currents. We feel sure that an extensive and careful examination of the localities, and of beaches where shingle is now being formed, will convince any one that they cannot have had such an origin.

1. We do not believe that any beach can be found with pebbles that have anything more than a slight resemblance to those at Newport. Those somewhat elongated may indeed be found where they are derived from slate rocks. But nowhere does the attrition of pebbles against one another produce deep indentations, and leave the one neatly fitting into the other, nay, one bent partially around the other, as is the case at Newport. If these phenomena were produced by original attrition how strange that they should have such an extraordinary development on Rhode Island, while it is not marked enough in any other conglomerate in our country save in Vermont, to have arrested the attention of geologists.

2. The remarkable joints in this conglomerate prove that the pebbles have been in a plastic state, and since the strata have been much folded, and consequently subjected to strong lateral pressure, how could the pebbles have escaped compression and modification of form? A mass of the conglomerate when broken open along the line of strike, a good deal resembles a plug of tobacco, which has been rolled into lumps and then subjected to strong pressure, so that the lumps are distorted and made to conform to all the irregularities around them.

3. The force by which the pebbles were flattened and indented must have operated laterally, as would result from the plication of the strata; folds in which are frequent. If there was a great superincumbent pressure and less in the direction of the strike, the same lateral force might have elongated the pebbles. But perhaps there may have been also a horizontal curvature in the strata, to aid in the work, as we shall explain when we come to describe the Vermont localities. It may not, however, be easy to show how this compressing force has operated where rocks have been so folded and disturbed as around Newport, for the conglomerate is in juxtaposition with granite, which has exerted a powerful metamorphic influence on other strata there; but if we can show the results of the agency, our main object will be accomplished.

4. The phenomena of the joints in this rock, conduct us most naturally to some polar force as the chief agent in their production. Mere shrinkage could not have separated the pebbles as smoothly; much less could a strain from beneath have thus fractured them; for sometimes the joints are not more than two or three inches apart, and if we suppose one of them to have been the result of fracture, yet how is the other to be obtained in that manner? A simple inspection of the rock in place will satisfy any one that no mechanical agency is alone sufficient to explain these phenomena. We have been driven to the supposition of some polarizing force acting upon soft materials. If, as Sir John Herschel supposes, cleavage may have resulted from a sort of crystallization in plastic materials, why may not joints come into the same category? Why should the conclusions drawn from the experiments of Mr. Fox upon the lamination of plastic clay, by electric currents, be limited to cleavage?

5. The Newport conglomerate is probably only a special variety of the extensive deposit of highly silicious pudding-stone found so abundantly between Boston and Rhode Island. Both have the same geological position, we believe, and were the Roxbury conglomerate to be brought into a plastic state, and the pebbles elongated and flattened by pressure, we think the result would resemble the Newport conglomerate.

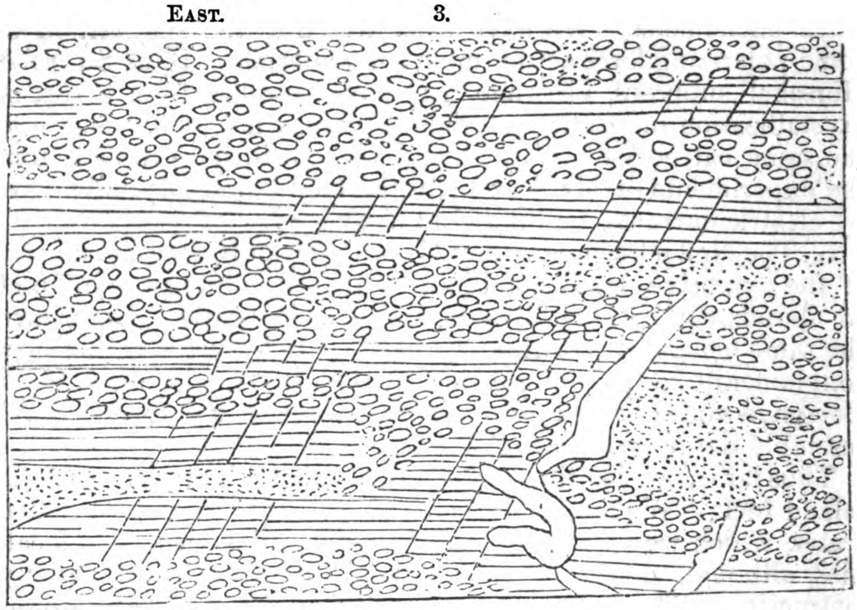
Thus far we are legitimately conducted, we think, by the Rhode Island rock. We are carried farther by the Vermont conglomerates, which we now proceed to describe. We select two localities, although doubtless many others might be found equally instructive. The rock occurs on both faces of the Green Mountains, and we can hardly doubt that it once formed a fold over the mountains, which denudation has swept away.

We have found this rock in connection with quartz rock, mica and talcose shists, and gneiss; sometimes merely in juxtaposition, as in the case of the quartz rocks, but sometimes interstratified. The conglomerates at the different localities may not

be identical as to geological age; yet we incline rather to the opinion, that quartz rocks, micaceous and talcose schist and gneiss, may be varieties of the same original rock, which metamorphism has sometimes converted into one and sometimes into others of the series. Quartz rock may be the residuum of certain silicates; the schists and gneiss are these silicates modified; any of these rocks, we think, might be formed out of the conglomerate under consideration, as we shall now endeavor to show. If so, we might perhaps find it in connection with them all, without implying a difference of age.

In the N.E. part of Wallingford, Vt., on the western slope of the Green Mts. on the hill north of David Hager's, is an interesting exhibition of the conglomerate. Numerous bowlders are scattered over the fields, which are instructive, but the embossed ledge half a mile north of Hager's is most so. It has been rounded and smoothed by the drift agency so as to show the pebbles and their alteration with the schists, very distinctly, as the following sketch of a portion of the ledge, taken by A. D. Hager, my assistant in the geological survey of Vermont, will evince. It will be seen that the schist often containing small pebbles or coarse grains of sand, is interstratified somewhat irregularly with the pebbles; just as we often see in the alluvial deposits, and in the sandstones that have not been metamorphosed. The drift striæ are quite distinct upon it, running southeasterly, as shown on the sketch, fig. 3.

EAST. 3.

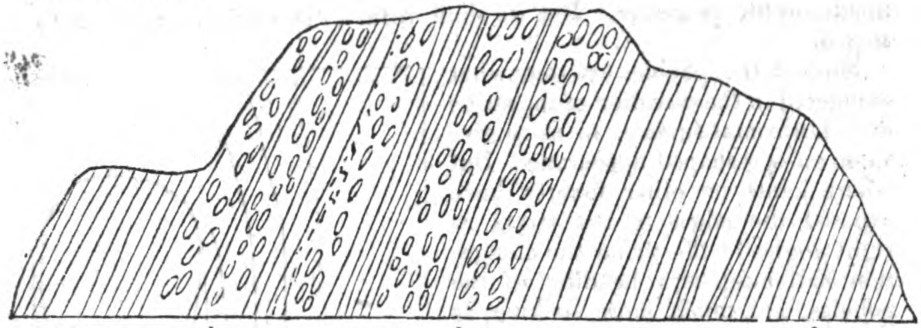


WEST.

The strike of these strata is about N.E. and S.W. and the dip 70° W., but it sometimes rises to 90° near by. To show its position in respect to a micaceous quartz rock, approaching micaceous schist, on the upper side, and to the Green mountain gneiss below it, we give the adjoining sketch, Fig. 4. These rocks constitute a single massive ledge,

with very few distinct strata-seams, and they seem as if only varieties of the same rock.

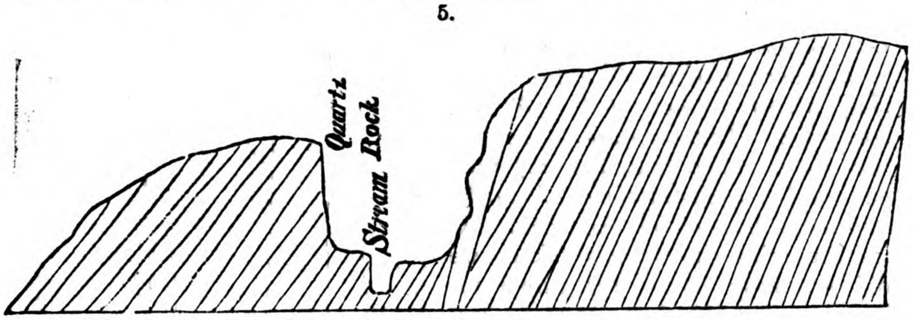
4.



a, micaceous quartz rock; *b*, *b*, conglomerate alternating with talc schist; *c*, talc schist; *d*, gneiss.

To show that the gneiss sometimes lies above the quartz and the schist, we give the following section, Fig. 5, only a few rods long, taken at an easily accessible locality, on the east side of the mountain; where, as we shall shortly see, the same rocks occur in juxtaposition. In the road from Ludlow to Mt. Holly, and near the line between the two towns, a small stream has cut a gorge, 40 or 50 feet deep, through a ledge of quartz rock. On the west side a trap dyke occupies a considerable part of the face of the rock, though more or less worn away. Talcose schist succeeds the quartz rock on the west side, dipping beneath it at a high angle. But on the east side, and lying upon the quartz at a less dip, is distinct gneiss, with more of feldspar than is usual in the Green mountain gneiss. The section below will give an idea of these facts, fig. 5.

5.

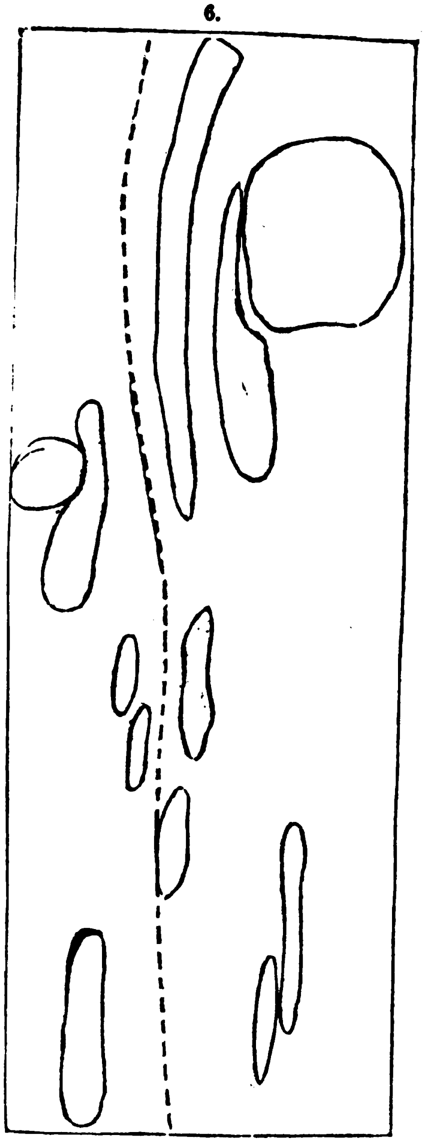


a, gneiss; *b*, trap dyke; *c*, *c*, quartz rock; *d*, talcose schists.

More than nine-tenths of the pebbles in the Wallingford conglomerates, are grey, somewhat granular, but often more or less hyaline quartz. White feldspar nodules are not uncommon. Quartz is sometimes disseminated through the feldspar, so as to form a sort of graphic granite. A few pebbles of distinct gneiss have been noticed. But it is not unusual for the micaceous cement to exhibit laminæ of feldspar, becoming, in fact, veritable gneiss; and perhaps the gneiss pebbles may all have thus originated. The most striking pebbles of feldspar, however, are seen in a finer variety of the rock, destitute of quartz pebbles, but showing small white rounded masses of feldspar, rarely over half an inch in diameter. We are of opinion that all the feldspar pebbles, as well as the narrow

strips of gneiss, are the result of metamorphism; that is, the pebbles were changed in mineral constitution, and the gneiss actually formed, by metamorphic processes. But we shall recur to this subject again in the sequel.

6.

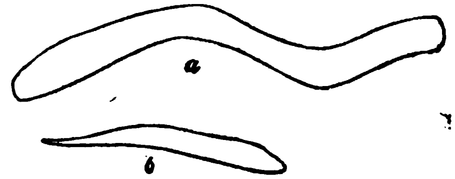


Most of the pebbles are somewhat elongated in the direction of the strike on a horizontal surface, so as to give them an egg-shaped appearance. But where joints or other fissures have exposed the edges of the strata at right angles to the strike the elongation flattening and bending of the pebbles, are much more striking, as the following outline, fig. 6, will show. Yet even here, a few pebbles appear not to have been at all modified in form:—two such are shown on the drawing. They seem not to have been plastic as the others were.

Single pebbles sometimes show striking curvatures, as on fig. 7, where *a* represents a pebble ten inches long, and a little more than one inch wide, *b* shows a smaller one less curved, $5\frac{1}{2}$ inches long, and half an inch wide.

A still more interesting case is shown in another boulder, a few feet long, represented imperfectly in fig. 8. Here the laminæ of the schists are bent considerably. On the inner side is a quartz pebble of considerable size, which is elongated and bent somewhat. But outwardly, the pebbles are so much flattened that they can hardly be distinguished from the quartzose laminæ of the rock. At the time this sketch was taken, we did not fully realize the important bearings it might have upon theory, and therefore we fear that it is not as minutely accurate as to every pebble, as could be desired. Still, the general facts above named are quite manifest, and these are all that are important.

7.

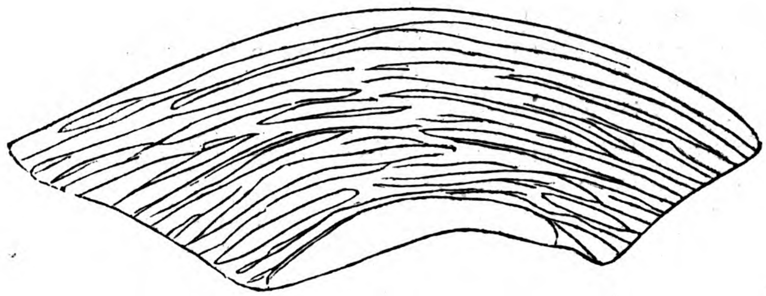


The preceding facts would justify some inferences additional to those drawn from the Newport rock. But we will first describe another locality on the east side of the Green mountains, where the metamorphic processes, begun at Newport and carried still

farther at Wallingford, are completed in the most satisfactory manner.

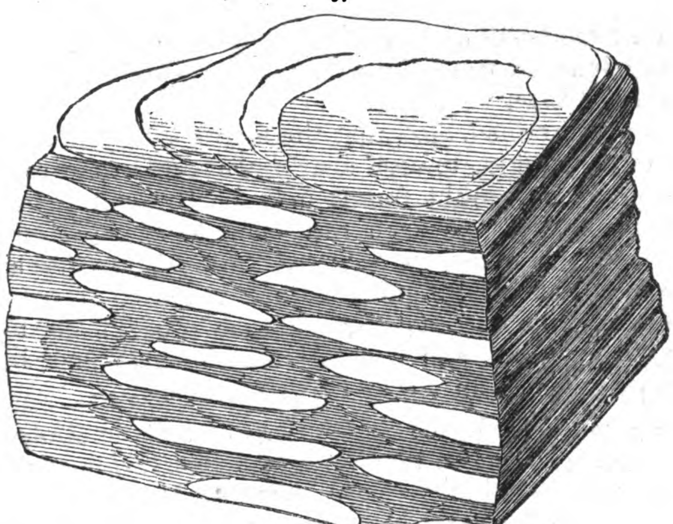
It is at Plymouth, along the west shore of Plymouth Ponds, most fully developed, perhaps, just where the ponds are separated by a mass of detritus, which was most probably the moraine of an ancient glacier, as will be described in our Report on the geology of Vermont.

8.



The schist, which here is decidedly talcose schist for the most part, and not far from some of the gold diggings, has an easterly dip; from 50° to 60°; and a direction a few degrees east of north. As the ledges crowd closely upon the road, a fine opportunity is presented of seeing the quartz pebbles that have not been much flattened on the exposed surfaces, having the aspect of a most decided conglomerate. Yet, if joints cross the rock, or if it be broken across, in the direction of the strike, the pebbles will for the most part, appear so flattened that they become almost len-

9.



ticular, or laminated. And if a fracture be made, or a joint occur, in a perpendicular direction, that is in the direction of the dip, the pebbles almost wholly disappear, or rather seem converted into the quartz laminæ of talcose schist. Both these facts are shown on fig. 9, which was copied

from one of the specimens obtained at this locality. Looking at one of these edges, we should have no hesitation in referring the rock to a highly quartzose variety of talcose schist. But looking at the other edge, we should have no doubt that the quartz laminæ are merely flattened and elongated pebbles. So strange and unexpected a fact leads the geologist to suspect that he may be deceived; but hundreds of specimens force him to the conclusion that he is not mistaken.

The quartz in this rock, both in Wallingford and Plymouth is generally white, or a light gray, and though sometimes granular, it approaches much nearer the hyaline variety, in most instances. It seems to be quite pure silex, rather than a silicate. In a few instances we find pebbles of granite, which are also flattened.

The suggestion has been made that what I regard as pebbles may be concretions. But the following facts seem to me to show this position to be untenable. 1. We have no other example of concretions formed of hyaline or granular quartz. 2. Concretions are never, as these nodules are, drawn out into the laminæ of schists. 3. Siliceous concretions, such as chalcedony, formed by gelatinous silex, are banded; but these nodules show no concentric structure. 4. Some of them consist of granite, gneiss, &c., which certainly never form concretions. 5. If these nodules are concretions, so are the pebbles of quartz and granite found loose in modified drift; or rather, no line of distinction can be drawn between the concretions and the pebbles.

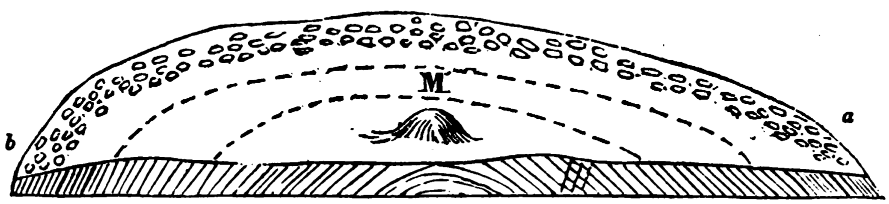
The thickness of the rock where the pebbles are indicated, is many hundred feet. Indeed, it may be much more, as I have not fully explored it. And if, as we suppose, the strata already described in connection with the conglomerate, are only that rock in an advanced state of metamorphism, the original thickness must have been very great.

We have ascertained, also, that the layers with pebbles extend as far south as Ludlow, though nearly converted there into mica schist; nor can we doubt but it may be traced much farther south and north, perhaps even the whole length of the Green mountains. At any rate, its occurrence on the opposite sides of that mountain at Wallingford and Plymouth, at points not much different from east and west of each other, leads to some interesting suggestions and conclusions. The distance between these two points is about ten and a half miles.

Myself and son, aided by the Senior Class of 1861, in Amherst College, have recently, (October, 1860), traversed this line, mostly on foot, and obtained as the result, the section below, fig. 10. The base of the section is the sea level, and the heights are laid off from the same scale, (about 13,000 feet to the inch), as the horizontal distance. This makes the Green mountains, (1390 feet above the ocean at Mt. Holly), appear of very diminutive size. But it is a true representation, except that the mountain for the sake of distinctness is a little too high. On both the flanks of the mountain, the dips are quite distinct, (they were measured

and the mean taken along the railroad from Ludlow to the summit as well as from the Plymouth Ponds). But in the central parts they are a good deal irregular. It will be seen that all the central portion of the mountain is gneiss of the peculiar kind known as the Green mountain gneiss. Above this lies, what has been called talcose schist, with which limestone is interstratified, and on the east side several beds of dark grey hyaline quartz, only a few feet thick. One of these beds, however, is snow-white. The upper part of the schist is the conglomerate already described, of a character so marked as not to be mistaken. At the west end we found several beds of limestone, but none of quartz. Beyond the conglomerate, however, and probably lying conformably upon it is an enormous development of granular quartz, which seems to have no counterpart on the east side of the mountain.

10.



A, B, C, H, D, E, F.

In this section *a*, *b*, shows the present surface, *a* being Wallingford, and *b* Plymouth. From A to B we have the talcose conglomerate; from R to C, mainly gneiss with some schist, and at least three beds of limestone, from C to D, gneiss with several trap dykes at H, the summit level of the railroad; from D to E, gneiss with talcose schist and at least two beds of limestone, and several thin beds of quartz; from E to F, talcose conglomerate. This last rock, so distinct and peculiar, forms a good starting point for our reasoning. I think no geologist will doubt that it once mantled over the mountain with the subjacent strata as represented in the above section. True, we have not found all the subordinate beds of limestone and quartz to correspond on the two sides of the mountain. But there is a general correspondence. The beds of limestone, especially, may have extended originally over the arch of the mountain, although it is not common to find limestone beds as thin as these, with so great a lateral extension. As to the beds of quartz, if this be in nearly all cases a rock produced in the wet way, all we can say is, that circumstances may have been more favorable for its production on the east than on the west side of the crest of the mountain.

Taking this section as a fair representation of the Green mountains, several important inferences follow.

1. It shows the gneiss of the Green mountains, to form a great anticlinal fold not a synclinal fold, as some have supposed. 2. This gneiss underlies the talcose schist, the limestone, the quartz rock and the conglomerate. 3. All these latter rocks probably once mantled over the gneiss, though they have mostly disappeared from the eastern side, except the talcose schist. 4. We

get an approximate idea of the amount of erosion from this part of the Green mountains. We have flattened down the curve described by the strata originally, more than perhaps we ought to do, yet it runs almost twice as high as Mansfield mountain, which is shown on the section at M, and is the highest point in the chain. The erosion at Mt. Holly cannot have been less than 8000 feet, which is nearly six times as great as the present height of the mountain at the summit level of the railroad. 5. We see here how the schists and gneiss may be formed out of conglomerate. This is perhaps the most important inference, and therefore it will be dwelt upon more fully in the sequel.

We proceed now to draw some inferences from the facts detailed respecting the Vermont conglomerates, additional to those already given. The Vermont localities teach the same lessons as those of Rhode Island, but we think they develop other conclusions.

1. They show, we think, that the elongating and flattening force in Vermont must have operated most energetically in the direction of the dip, whereas in Rhode Island, it was most powerful in the direction of the strike. In the latter case it was as if two men had taken hold of the ends of a plastic mass, and pulled it out horizontally; but in Vermont it is as if one had stood at the top of a steep hill, and the other at the bottom. This is evident from the fact that when we look at the edges of the rock laid bare along the line of the dip, we see little more than the flattened edges of the pebbles in the form of laminæ, but if laid bare along the line of strike we see the scattered and even lenticular ends of the pebbles, as shown in fig. 9, already given. The fact however, that the pebbles are lenticular on the basset edges of the strata, shows that the whole force was not exerted in the direction of the dip. They were a good deal flattened horizontally, but never so vertically.

2. We think we can get a glimpse in Vermont of the mode in which the force acted to elongate and flatten the pebbles. We refer to the bowlder shown in fig. 8, where it is obvious that the bending of the rock, if it was plastic could produce that effect, because the outer portions must be extended over wider and wider spaces. Hence, as in the figure, a pebble on the interior part, might be only moderately extended while the outer ones were stretched almost into mere laminæ.

Apply now this principle to fig. 10, which shows the manner in which, as we suppose, the strata were folded over the top of the Green mountains. The effect would be to stretch them out more in the direction of the curve, or dip, than at right angles to it; although the strain would spread them in that direction also, to some extent, and it may be that the irregularities that must have accompanied such great movements as the folding up of a

mountain chain, would make the horizontal elongation in some places the greatest.

We do not assert that this explanation of the phenomena is the true one, but only that it shows one mode in which the process might have been performed. Whether any horizontal flexure can be found in the Rhode Island rock to explain the elongation there, we are unable to say, because the theory was not in our minds when we examined those rocks.

3. The facts detailed, disclose to us some of the modes in which the laminæ of the schists and of gneiss may have been produced. The first mode is by chemical agencies. Out of the cement of conglomerate these agencies have formed mica and talc, whose parallel structure was probably the result, mainly of pressure. We doubted for a time whether we could justly include gneiss among the rocks that may have originated from conglomerate; for we have not found as yet decided examples of pebbles in this rock. Yet so intimately connected with the conglomerate schists is the Green mountain gneiss, as the preceding details show,—so little, in fact, does it differ from the schists, that we cannot doubt but both originated from the same parent source. But the conglomerate at Wallingford affords still stronger evidence and shows us the modes in which the gneiss was produced from the conglomerate. Some of the elongated pebbles there are gneiss. But we doubt whether they were originally so; for quite often the cement is changed to gneiss. To effect this change it was only necessary that feldspar should be interpolated between the laminæ of mica or talc. And no one who has seen the specimens will imagine that it could have been introduced mechanically, by deposition, for example. The last way, or crystallization from solution, is the only other probable mode. Gneiss, perhaps, has been generally formed by such an interpolation of feldspar into the schists, and this may be the reason why we seldom, perhaps never, see pebbles in that rock. We do not yet despair, however, of finding pebbles in gneiss, now that we know how to look for them. Indeed, some varieties of it contain nodular elongated masses of feldspar interlaminated with mica which may perhaps have been originally pebbles chemically changed and elongated mechanically.

The second agency by which conglomerate has been converted into schists, is mechanical. By some force they have been flattened and elongated till they have become the quartzose laminæ of the schists. It is not probably possible for us to convey a very clear and complete idea of the evidence of this position. Would that our readers could, as we have done, visit the localities again and again and become familiar with the striking specimens there, by repeated and careful examination. From our own experience, it would not surprise us, if the conversion of the pebbles of con-

glomerates into the laminæ of schists should be pronounced preposterous by able geologists. So the idea seemed to us at first, when the facts forced it upon our attention. But as the facts compelled us to give up our scepticism, so we think it will be with any candid mind. Looking at almost any specimen of the talcose conglomerate schist, on the edge corresponding to the dip (B fig. 9,) we should see nothing but alternating laminæ of quartz and talc, or mica, and pronounce it a good example of the rock which we have called, and which is generally called, talcose schist. But a fracture at right angles reveals the flattened pebbles (A fig. 9), and shows us that their edges are what we have regarded as laminæ. Let the process of flattening be carried a little farther, and no evidence will remain that they ever were pebbles. Who knows how extensively the process may have been thus carried through in the schists and gneiss of the Green mountains, and how large a part of them may once have been conglomerate? Our aim, however, is not to show the extent of the metamorphosis, but only to prove its occurrence on a large scale.

4. A fourth conclusion forced upon us by the facts is, that the chemical constitution of the pebbles has generally been altered in the process of metamorphism without obliterating their original mechanical character.

As has been repeatedly stated, most of the pebbles in the Vermont rock are quite pure quartz, having often more or less of a vitreous aspect. In fact it is nearly pure silex; and it is that form of silex which is absolutely insoluble in anything but hydrofluoric acid; nor can we suppose the presence of any heat high enough to melt it, without completely destroying the forms of the pebbles. Yet the evidence that they have been in a plastic state so as to be molded by pressure is too decided to be resisted. How then have they been softened?

Let us recur to the conglomerate at Newport. Most of the pebbles there are not pure quartz but rather silicates of such bases as alumina, magnesia, lime and iron. Now the silicates are soluble by water containing alkalies; and such quartz as is seen in the Vermont pebbles may be the residuum of the decomposition of the silicates, the bases being abstracted to form other compounds, the quartz is left.

This may be the most probable theory of the origin of quartz rock generally. Even if we suppose it produced from sandstone, we know of no other way in which it could have been formed; for nearly all the sandstones are silicates.

But suppose the silicates in the form of pebbles to be permeated by water containing alkalies, could their bases be abstracted without entirely destroying the form of the pebbles? We do not see why this could not be done, if the mass is kept in such a state by the water that the laws of chemical affinity

should prevail, forming new compounds, and leaving the quartz behind. The chief effect upon the pebble would be to reduce its bulk, though we do find sometimes the cement so strongly adhering to the pebble, that it can hardly be separated so as to leave a smooth surface. The bases, we think, could be mostly used in forming the micaceous or talcose cement, and if there was a good deal of pressure upon the whole rock, as we may reasonably suppose, if the pebbles did shrink some, the cement would increase and the whole mass would be compacted together.

To sustain the position that the mineral constitution of pebbles in conglomerates is sometimes entirely changed without destroying their character as pebbles, we would refer to another kind of conglomerate which we have found along the eastern border of Vermont, and farther south in Massachusetts. This rock, so far as we know, has never been described in treatises on geology; but we know of four localities on the west side of Connecticut river, and its character and origin are quite obvious. We cannot here go into full details as to this rock, but shall mention only the facts that bear especially upon the point under consideration.

We define this rock as a conglomerate, with a cement of syenite, or granite, or as a syenite or granite containing pebbles, sometimes thickly and sometimes sparsely disseminated. We have found it in Whately, Mass., on Ascutney, and in Barnet, Vt. On the southeast point of Little Ascutney we find a conglomerate, or perhaps a breccia, which is made of fragments of silex and some mica, probably a sandstone with nearly pure quartz. On one side of this mass, it passes, without an intervening seam, into a porphyry, and this into granite, all forming one undivided ledge; so that the conclusion is forced upon us that the granite and porphyry have been formed out of the conglomerate. Most of the rock on Ascutney takes hornblende into its composition, and thus becomes syenite, and this abounds in black rounded masses, which are, for the most part, crystalline hornblende, with some feldspar, and which are probably pebbles transmuted. At Granby, the pebbles manifestly rounded, are either mica schist, or white almost hyaline quartz, just such as form the pebbles in the conglomerates at Wallingford and Plymouth, and the base is a fine-grained syenite, passing sometimes almost into mica schist. A pebble of hornblende schist is also sometimes seen.

In bowlders of this conglomerate found in Northampton, Mass., and probably derived from Whately, the most abundant pebbles are those of the brown sandstone, considerably metamorphosed and flattened. Those of hornblende schist are common. Sometimes they are merely crystalline hornblende, not generally laminated however, but mixed with some feldspar, and

they may become syenite, and are frequently porphyritic by distinct crystals of feldspar. The cement is syenite, often more hornblendic than usual.

When the pebbles are highly crystallized, they become so incorporated with the matrix that it is difficult to separate them with a smooth surface, and if we are not mistaken, they pass insensibly into those rounded nodules chiefly hornblendic, so common in syenite, especially that of Ascutney. We think these are produced from the metamorphoses of pebbles which have become crystalline since they were formed into conglomerate. We find them, as we think, in all stages of the metamorphosis.

These facts certainly give great plausibility to the view which supposes granite and syenite to be often the result of the metamorphosis of stratified rock. But they afford a presumption, also, in favor of the position, that pebbles, which have been plastic for ages in the rocks, may have greatly changed their mineral constitutions without essentially altering their external form. This might certainly be thoroughly done if those pebbles were permeated by water containing in solution powerful chemical agents. Some of the ingredients might thus be abstracted from the pebbles and new ones supplied, if needed to form the new compounds.

In all the cases of pebbles in unstratified rocks described above, syenite has formed the matrix. But at the meeting of the American Association at Springfield, Prof. Hubbard of Dartmouth College exhibited a specimen of pure white granite from Warren in New Hampshire, in which there lay imbedded a rounded bowlder of hornblende rock, more than a foot in diameter, and easily separable from the granite. We had no doubt but that it was mechanically rounded, nor much doubt but that its mineral character had been changed since it was enveloped in granite. Hornblende bowlders in the drift are among the most infrequent of all rocks, because hornblende schist is very limited. But in the older metamorphic conglomerates, such nodules are the most common of all, and this fact furnishes the presumption of their metamorphic origin.

The facts which we have detailed respecting the occasional presence of feldspar pebbles in the Vermont conglomerates and especially of the occasional conversion of the cement into gneiss, are most probably examples of a change of mineral character during metamorphosis. It seems hardly possible to account for a cement of crystalline mica or talc, in any other way. But when we find feldspar interpolated between the laminæ, any other than a chemical origin appears improbable. We cannot therefore but regard feldspar in perhaps all cases in the crystalline rocks, as the result of metamorphism. Silicates probably furnished the ingredients, which being abstracted by hot water,

left the excess of silica in the form of quartz, and forced the feldspar and mica to fill up the interstices. The feldspar which has converted the cement into gneiss, could have had no other origin and this fact in connection with all the rest which have been adduced, affords a presumption that feldspar in nearly all the crystalline rocks, stratified and unstratified, is a product of metamorphism.

We will add a few words as to other localities of conglomerates with flattened pebbles. The subject has opened upon us in its fullness so recently that we have not had time to visit others. But we happen to have specimens from Bernardston, Mass., in which the elongation and flattening are decided in a conglomerate micaceous schist connected with clay slate and quartz rock. The same is true to some extent in a like rock from Bellingham, Mass. Still more decided is it in bowlders of the conglomerate-syenite described above from North Hampton; as it is also in the same variety of rock on Little Ascutney. In fact we predict that this phenomenon will be found present in very many of the thoroughly metamorphic conglomerates, although not noticed by observers, because their attention was not called to it.

Less than a mile north of the conglomerate locality in Plymouth, Vt., on the east side of the pond, and nearly on the strike of the conglomerate, occurs a remarkable variety of marble in an interstratified bed several rods wide. It consists of a ground of dark limestone through which are disseminated numerous elongated masses from half an inch to six inches long, and from a quarter of an inch to an inch wide, of white, semicrystalline carbonate of lime. Their larger axes lie as nearly parallel to one another as those of the quartzose conglomerate. What their origin was I have scarcely ventured to conjecture. One naturally enquires, however, whether they may not be elongated organic remains, such as corals. At any rate, the enquiry may be worthy of consideration, whether they are not masses elongated by the same force that has acted on the not far distant conglomerate. This idea did not occur to me when in the vicinity, and therefore I did not go to determine the point. If there be any foundation for this suggestion, we should expect that the longer axes of these nodules would correspond more nearly with the dip than with the strike. I have not the slightest recollection whether it is so.

The chief interest in the facts and conclusions in this paper, lies in the light they cast upon metamorphism. We had indeed felt that there was a good deal of probability in the general doctrines of metamorphism advanced by able men. But never before have we had the various steps of the process brought directly under our eyes, and so distinctly as to confound our scepticism and challenge our belief. Instead of any prejudices in favor of the conclusions to which we have been brought, our prepossessions have been the other way. But we could not resist evidence so clear, and we find that our new views greatly illustrate the subject of metamorphism. It seems to us difficult to conceive how geologists can avoid the conclusions we have presented, if

they will visit and study the localities we have pointed out. We have indeed, specimens from them all, in the Amherst Cabinets, to the amount of several hundred pounds, and they illustrate nearly all the points we have brought out. But we advise gentlemen not to substitute an inspection of these, for the more satisfactory exhibitions in the mountains.

Amherst College, Nov. 1, 1860.

NOTE.—A brief and imperfect summary of the preceding facts and arguments having been presented by me last autumn before the Boston Natural History Society, Dr. Charles T. Jackson, who presided at the meeting, expressed his dissent from my views as to the manner in which the pebbles had been flattened and distorted, and his conviction that they had either been worn into these shapes by water, previous to aggregation, or that some of these were concretions. At a subsequent meeting, Prof. Wm. B. Rogers expressed similar views, which appeared in the published proceedings of the society.* I do not understand these distinguished geologists to have made up their minds very decidedly on the subject, especially as they have not visited the Vermont localities. But objections suggested by gentlemen of such large geological experience, deserve serious consideration.

I have already stated my objections to the theory which they adopt as to the forms of the pebbles. Prof. Rogers suggests as an objection to my views, that the pressure which I suppose to have flattened and distorted the pebbles, has not produced cleavage. But this conglomerate is not a rock in which cleavage is ever found. It is a foliated, or schistose rock. It has joints in it, such as prove very clearly that it was once in a state more or less plastic; but these (the most perfect ones especially,) cross the laminæ at nearly right angles, and could never have been produced by pressure. It is a fact, however, that some of the larger pebbles, particularly at their extremities, do show the commencement of a schistose structure, probably the result of pressure. Yet the facts do not require us to suppose the pressure on this rock to have been of the most powerful kind. In some cases indeed, as at Plymouth, the pebbles are compressed into laminæ, but in general, they are only moderately flattened, and sometimes not at all. If only moderately plastic, such effects could not have required a very enormous force.

Another objection is, that the compression has not distorted the fossil Lingulæ found in the pebbles on Taunton river, and at Newport. But I am not aware that the pebbles in the conglomerate of Taunton river, have been compressed and elongated; nor have they been, in but a part of that around Newport.

* See under GEOLOGY in this number the remarks of Prof. Rogers.

Whether they have been in the particular pebbles containing the fossils, I am unable to say.

A third objection rests upon the fact that some of the pebbles have scarcely been flattened at all, and their longer axes cross the foliation;—though I do not myself recollect to have seen any where the position was much awry. But some of them, on account of their composition, may have been scarcely at all plastic, or had such a position that the pressure affected them but slightly. We certainly ought to expect such cases.

I have been led, of late, to a reperusal of the able papers that have appeared for several years past in the English journals, on cleavage, compressed and distorted fossils, and particles of slate, by Sharpe, Sorby, Tyndall, Scrope, Scheerer, and Haughton. The result is, a conviction that the facts which I have given respecting the conglomerates, are only another phase of the phenomena described by these eminent geologists. If the facts they adduce prove the elongation and expansion of slate, limestone and fossils, as is generally conceded, although proved mainly by the microscope, why should we think it strange that the like effects may have been produced upon conglomerates, so as to show themselves on a large scale, and to unaided vision? The manner in which the veteran geologist, Scrope, supposes gneiss and mica schist may have been formed out of granite, (which he has illustrated by figures, *Phil. Magazine*, vol. li, p. 196), whatever we may think of the hypothesis, corresponds very nearly with some of my suppositions, or rather *facts*, as to the conversion of conglomerates into schists. And the ideas of most of these writers as to the former plastic condition of most of the rocks, correspond with those which I have expressed. If I am wrong, then, I have the consolation of being in good company.

Prof. Tyndall, in his recent work on the Alpine Glaciers, has referred to an interesting specimen in London, analogous to the conglomerates of Rhode Island and Vermont.

In the museum of the Government school of Mines, he says, "we have a collection of quartz stones placed there by Mr. Salter, and which have been subjected to enormous pressure, in the neighborhood of a fault. These rigid pebbles, have in some cases, been squeezed against each other so as to produce a mutual flattening and indentation. Some of them have yielded along planes passing through them, as if one half had slidden over the other; but the reattachment is very strong. Some of the larger stones, moreover, which have endured pressure at a particular point, are fissured radially around the point. In short, the whole collection is a most instructive example of the manner and extent to which some of the most rigid substances

in nature can yield on the application of a sufficient force.—(*Glaciers of the Alps*, p. 404, Amer. Ed.)

Though these specimens are not so definitely described as we could wish, we presume they are conglomerates with flattened quartz pebbles, like those in Rhode Island and Vermont. Our objections to Prof. Tyndall's hypothesis, which imputes the effect wholly to the mechanical compression of solid quartz, are as follows:

1. The compression of pure quartz pebbles, such as some of those in Rhode Island, and most of those in Vermont, would break and crush them, nor have we any reason to suppose that the fragments could be reconstructed so as to form hyaline masses, without fissures. There is no fluid, as in ice, to produce regelation; nor could the particles be brought near enough for molecular attraction, without being crushed into the finest powder, by such a pressure as the facts show not to have been exerted upon the conglomerates.

2. The compressing force has not been great enough to destroy except partially, the form of the pebbles. It has not crushed but only moulded them, except that now and then, one has been fractured. If it had been powerful enough to compress and distort solid quartz and to reunite its particles, it must have destroyed all marks of a mechanical origin in the pebbles.

3. There is evidence, as we have tried to show, in the preceding discussion, that many of the pebbles, especially in the Vermont rocks, have undergone a chemical change; that certain silicates have been abstracted from them, leaving the excess of silica in the form of quartz. This, of course, would require such a degree of plasticity, as to enable water to permeate the mass.

March 20th, 1861.

Art. XXXV.—*On some points in American Geology;* by T. Sterry Hunt, F.R.S., of the Geological Survey of Canada.

The recent publication of two important volumes on American geology seems to afford a fitting occasion for reviewing some questions connected with the progress of geological science, and with the history of the older rock formations of North America. The first of these works is the third volume of the Palæontology of New York by James Hall; we shall not attempt the task of noticing the continuation of this author's labors in the study of organic remains, labors which have by common consent placed him at the head of American palæontologists, but we have to call attention to the introduction to this third volume, where in about a hundred pages Mr. Hall gives us a clear and admirable

summary of the principal facts in the geology of the United States and Canada, followed by some theoretical notions on the formation of mountain chains, metamorphism and volcanic phenomena, where these questions are discussed from a point of view which we conceive to be of the greatest importance for the future of geological science. A publication of this introduction in a separate form, with some additions, would we think be most acceptable to the scientific public.

The other work before us is Prof. H. D. Rogers' elaborate report on the geology of Pennsylvania, giving the results of the Survey of that State for many years carried on under his direction, and embracing a minute description of those grand exhibitions of structural geology, which have rendered that State classic ground for the student. The volumes are copiously illustrated with maps, sections and figures of organic remains, and the admirable studies on the coal fields of Pennsylvania and Great Britain add much to its value.

The oldest series of rocks known in America is that which has been investigated by the officers of the Geological Survey of Canada, and by them designated the Laurentian system. It is now several years since we suggested that these rocks are the equivalents of the oldest crystalline strata of western Scotland and Scandinavia.* This identity has since been established by Sir R. I. Murchison in his late remarkable researches in the northwestern Highlands, and he has adopted the name of the Laurentian system for these ancient rocks of Ross, Sutherland, and the Western Islands, which he at first called fundamental gneiss.† These are undoubtedly the oldest known strata of the earth's crust, and therefore offer peculiar interest to the geologist. As displayed in the Laurentide and Adirondack mountains, they exhibit a volume which has been estimated by Sir William Logan to be equal to the whole palæozoic series of North America in its greatest development. The Laurentian series consists of gneiss, generally granitoid, with great beds of quartzite, sometimes conglomerate, and three or more limestone formations, (one 1000 feet in thickness) associated with dolomites, serpentines, plumbago, and iron ores. In the upper portion of the series an extensive formation of rocks, consisting chiefly of basic feldspars without quartz and with more or less pyroxene, is met with. The peculiar characters of these latter strata, not less than the absence of argillites and talcose and chloritic schists, conjoined with various other mineralogical characteristics seem to distinguish the Laurentian series throughout its whole extent, so far as yet studied, from any other system of crystalline strata. It

* Esquisse Géologique du Canada, 1855, p. 17.
† Quar. Journal Geol. Society, vol. xv, 353; xv, 215.

appears not improbable that future researches will enable us to divide this series of rocks into two or more distinct systems.

Overlying the Laurentian series on Lake Huron and Superior, we have the Huronian system, about 10,000 feet in thickness, and consisting to a great extent of quartzites, often conglomerate, with limestones, peculiar slaty rocks, and great beds of diorite, which we are disposed to regard as altered sediments. These constitute the lower copper-bearing rocks of the lake region, and the immense beds of iron ore at Marquette and other places on the south shore of Lake Superior have lately been found by Mr. Murray to belong to this series, which is entirely wanting along the farther eastern outcrop of the Laurentian system. This Huronian series appears to be the equivalent of the Cambrian sandstones and conglomerates described by Murchison, which form mountain masses along the western coast of Scotland, where they repose in detached portions upon the Laurentian series.

Besides these systems of crystalline rocks, the latter of which is local and restricted in its distribution, we have along the great Appalachian chain, from Georgia to the Gulf of St. Lawrence, a third series of crystalline strata, which form the gneissoid and mica slate series of most American geologists, the hypozoic group of Prof. Rogers, consisting of feldspathic gneiss, with quartzites, argillites, micaceous, epidotic, chloritic, talcose and specular schists, accompanied with steatite, diorites and chromiferous ophiolites. This group of strata has been recognized by Safford in Tennessee, by Rogers in Pennsylvania, and by most of the New England geologists as forming the base of Appalachian system, while Sir William Logan, Mr. Hall, and the present writer have for many years maintained that they are really altered palæozoic sediments, and superior to the lowest fossiliferous strata of the Silurian series. Sir William Logan has shown that the gneissoid ranges in Eastern Canada have the form of synclinals, and are underlaid by shales which exhibit fossils in their prolongation, while his sections leave no doubt that these ranges of gneiss, with micaceous, chloritic, talcose and specular schists, epidosites, quartzites, diorites and ophiolites, are really the altered sediments of the Quebec group, which is a lower member of the Silurian series, corresponding to the Calciferous and Chazy formations of New York, or to the Primal and Auroral series of Pennsylvania. Prof. Rogers indeed admits that these are in some parts of Pennsylvania metamorphosed into feldspathic, micaceous and talcose rocks, which it is extremely difficult to distinguish from the hypozoic gneiss, which latter, however, he conceives to present a want of conformity with the palæozoic strata.

To this notion of the existence of two groups of crystalline rocks similar in lithological character but different in age, we

have to object that the hypozoic gneiss is identical with the Green Mountain gneiss, not only in lithological character, but in the presence of certain rare metals, such as chrome, titanium, and nickel which characterise its magnesian rocks; all of these we have shown to be present in the unaltered sediments of the Quebec group, with which Sir William Logan has identified the gneiss formation in question. Besides which the lithological and chemical characters of the Appalachian gneiss are so totally distinct from the crystalline strata of the Laurentian system, with which Prof. Rogers would seem to identify them, that no one who has studied the two can for a moment confound them. Prof. Rogers is therefore obliged to assume a new series of crystalline rocks, distinct from both the Laurentian and Huronian systems, but indistinguishable from the altered palæozoic series, or else to admit that the whole of his gneissic series in Pennsylvania is, like the corresponding rocks in Canada, of palæozoic age.* We believe that nature never repeats herself without a difference, and that certain variations in the chemical and mineralogical constitution of sediments mark successive epochs so clearly that it would be impossible to suppose the formation in adjacent regions of a series of crystalline schists like those of the Alleghanies contemporaneous with the sediments which produced the Laurentian system. We have elsewhere indicated the general principles upon which this notion of a progressive change in the composition of sediments is based, and shown how the gradual removal of alkalies from aluminous rocks has led to the formation of argillites, chloritic and epidotic rocks, at the same time removing carbonic acid from the atmosphere, while the resulting carbonate of soda by decomposing the calcareous and magnesian salts of the ocean, furnished the carbonates for the formation of limestones and dolomites, at the same time generating sea salt.†

Closely connected with these chemical questions is that of the commencement of life on the earth. The recognition beneath the Silurian and Huronian rocks, of 40,000 feet of sediments analogous to those of more recent times, carries far back into the

* Dr. Bigsby in 1824 described an extensive tract of gneissoid rocks on Rainy Lake and Lake Lacroix, north of Lake Superior. The general course of the strata he states to be "from N.W. to N. by W., with a corresponding easterly dip;" but he elsewhere speaks of the gneiss as running (dipping?) E.N.E. This gneiss often contains beds and disseminated grains of hornblende, and passes in some places into micaceous, chloritic and greenstone slates, and syenite. Staurotide is abundant in the mica schists, and octahedral iron occurs in the chloritic slates. A porphyritic granite containing beryl is also met with in this region. This gneiss is regarded by Dr. Bigsby as belonging "to transition rocks, from its constant proximity to red sandstone, the oldest organic limestone, and trap." (Am. Jour. Sci. (1), viii, 61). The lithological and mineral characters of these crystalline strata seem to be distinct from those of the Laurentian system, and to resemble those of the Appalachians. Too much praise cannot be ascribed to Dr. Bigsby for his early and extensive observations on the geognosy and mineralogy of British North America.

† This Journal [2], xxv, 102, 445, xxx, 133; and Quar. Jour. Geol. Soc., xv, 488.

past the evidence of the existence of physical and chemical conditions, similar to those of more recent periods. But these highly altered strata exclude, for the most part, organic forms, and it is only by applying to their study the same chemical principles which we now find in operation that we are led to suppose the existence of organic life during the Laurentian period. The great processes of deoxydation in nature are dependent upon organization; plants by solar force convert water and carbonic acid into hydrocarbonaceous substances, from whence bitumens, coal, anthracite and plumbago, and it is the action of organic matter which reduces sulphates, giving rise to metallic sulphurets and sulphur. In like manner it is by the action of dissolved organic matters that oxyd of iron is partially reduced and dissolved from great masses of sediments, to be subsequently accumulated in beds of iron ore. We see in the Laurentian series beds and veins of metallic sulphurets, precisely as in more recent formations, and the extensive beds of iron ore hundreds of feet thick which abound in that ancient system, correspond not only to great volumes of strata deprived of that metal, but as we may suppose, to organic matters, which but for the then great diffusion of iron oxyd in conditions favorable for their oxydation, might have formed deposits of mineral carbon far more extensive than those beds of plumbago which we actually meet in the Laurentian strata.

All these conditions lead us then to conclude to the existence of an abundant vegetation during the Laurentian period, nor are there wanting evidences of animal life in these oldest strata. Sir William Logan has described forms occurring in the Laurentian limestone which cannot be distinguished from the silicified specimens of *Stromatopora rugosa* found in the Lower Silurian rocks. They consist of concentric layers made up of crystalline grains of white pyroxene in one case and of serpentine in another, the first imbedded in limestone and the second in dolomite; we may well suppose that the result of metamorphism would be to convert silicified fossils into silicates of lime and magnesia. The nodules of phosphate of lime in some beds of the Laurentian limestones also recall the phosphatic coprolites which are frequently met with in Lower Silurian strata, and are in the latter case the exuviæ of animals which have been fed upon *Lingula*, *Orbicula*, *Conularia* and *Serpulites*, the shells and tubes of which we have long since shown to be similar in composition to the bones of vertebrates.* So far therefore from looking upon the base of the Silurian as marking the dawn of life upon our planet, we see abundant reasons for supposing that organisms, probably as varied and abundant as those of the

* Logan and Hunt, Amer. Jour. Sci. [2], xvii, 235.

palæozoic age, may have existed during the long Laurentian period.

Along the northern rim of the great palæozoic basin of North America the Potsdam sandstone of the New York geologists is unquestionably the lowest rock from below Quebec to the Island of Montreal, and thence passing up the valley of Lake Champlain and sweeping round the Adirondack mountains, until it reënters Canada and soon disappears to the north of Lake Ontario, where the Birdseye and Black River limestones repose directly upon the Laurentian rocks, and furthermore overlie the great Lake Superior group of slates and sandstones, which reposing on the unconformable Huronian system, constitute the upper copper-bearing rocks of this region. This Lake Superior group, as Sir William Logan remarks, may then include the Potsdam, Calciferous and Chazy, and thus be equivalent in part to the Quebec group hereafter to be described.

Passing westward into the Mississippi valley we again find a sandstone formation, which forms the base of the palæozoic series, and is considered by Mr. Hall to be the equivalent of the Potsdam. Here it occasionally exhibits intercalated beds of silico-argillaceous limestone, in which occur abundant remains of trilobites of the genera *Dikellocephalus*, *Menocephalus*, *Arionellus*, and *Conocephalus*. Passing upwards this sandstone is succeeded by the Lower Magnesian limestone, which is the equivalent of the Calciferous sand-rock of New York, and in Missouri, where it is the great metalliferous formation, alternates several times with a sandstone, constituting the Magnesian Limestone series, which in Missouri attains a thickness of 1300 feet. The same thing is observed to a less degree in Wisconsin and Iowa; throughout this region the higher beds of the Potsdam sandstone are often composed of rounded oolitic granules, and the beds of passage are frequently of such a character as to lead to the conclusion that they have been deposited from silica in solution, and are not mechanical sediments.* For a discussion of some facts with regard to the chemical origin of many silicious rocks, see this Journal, [2], xviii, 381.

Evidences of disturbance during the period of its deposition are to be found in the brecciated beds, sometimes fifty feet in thickness, which occur in the Calciferous sandrock of the northwest, and are made of the ruins of an earlier sandstone. In Missouri, the Birdseye and Black River limestones repose directly upon the Lower Magnesian limestone, while farther north, a sandstone intervenes, occupying the place of the Chazy limestone.

* See Mr. Hall's Introduction, to which we are indebted for many of these facts regarding the formation of the west, and also the Reports of the Geological Survey of Missouri.

The Potsdam sandstone of the St. Lawrence valley, has for the most part the character of a littoral formation, being made up in great part of pure quartzose sand, and offering upon successive beds, ripple and wind marks, and the tracks of animals. Occasionally it includes beds of conglomerate, or as at Hemmingford, encloses large rounded fragments of green and black shale; it also exhibits calcareous beds apparently marking the passage to the succeeding formation, which although called a Calciferous sandrock, is for the most part here, as in the west, a magnesian limestone, often geodiferous, and including calcite, pearl spar, gypsum, barytes and quartz. Sir William Logan had already shown that the fauna of the Potsdam and Calciferous in Canada are apparently identical, (Can. Nat., June, 1860; This Journal, [2], xxxi, 18), and Mr. Hall has arrived at the same conclusion with regard to the more extended fauna of these formations in the valley of the Mississippi, so that these two may be regarded as forming but one group. While in the west *Dikellocephalus* occurs both in the lower sandstones and the magnesian limestones, *Conocephalus minutus*, found in the Potsdam on Lake Champlain, and identified by Mr. Billings, has lately been detected by him in specimens from the sandstones of Wisconsin with *Dikellocephalus*, which genus has there been found to pass upwards into the magnesian limestones. On the other hand, the sandstones of Bastard in Canada, having the characters of the Potsdam, contain *Lingula acuminata* and *Ophileta compacta*, species regarded as characteristic of the Calciferous, together with two undescribed species of *Orthoceras*, and in another locality a *Pleurotomaria* resembling *P. Laurentina*. The researches of Mr. Billings have extended the fauna of the Calciferous in Canada to forty-one species, and the succeeding Chazy formation to 129 species. The thickness of this latter division in the St. Lawrence valley is about 250 feet, and it includes in its lower part about fifty feet of sandstones with green fucoidal shales and a bed of conglomerate. The Calciferous has a thickness of about 300 feet, while the Potsdam may be estimated at not far from 600 feet.

We have then seen that along the northeastern outcrop of the great American basin in Canada and New York, the base of the Palæozoic series is represented by less than 1000 feet of sandstones and dolomites, reposing directly upon the Laurentian system. A very different condition of things is, however, found in the more central parts of the basin. According to Prof. Rogers, the older Primal slates, which form the base of the palæozoic system, attain in Virginia a thickness of 1200 feet, and are succeeded by 300 feet of Primal sandstone marked by *Scolithus*, which he considers the Potsdam, followed by the upper Primal slates, consisting of 700 feet of greenish and brownish talco-argillaceous shales with fucoids. To these succeed his

Auroral division, consisting of sixty feet or more of calcareous sandstone, the supposed equivalent of the Calciferous sandrock, followed by the Auroral limestone, which is magnesian, and often argillaceous and cherty in the upper beds. Its thickness is estimated at from 2500 to 5500 feet, and it is supposed by Rogers to include the Chazy and Black River limestones, while the succeeding Matinal division exhibits first, from 300 to 500 feet of limestone, (Trenton), secondly, 300 to 400 feet black shale, (Utica), and thirdly, 1200 feet of shales with red slates and conglomerates, (Hudson River Group), thus completing the Lower Silurian series.

In Eastern Tennessee, Mr. Safford describes, (1st.) on the confines of North Carolina, a great volume of gneissoid and micaceous rocks similar to those of Pennsylvania, succeeded to the west by (2nd.) the Ococee conglomerates and sandstones, with argillites, chloritic, talcose and micaceous slates, and occasional bands of limestone, all dipping, like the rocks of the 1st division, to the S.E. In the 3d place we have the Chilhowee sandstones and shales, several thousand feet in thickness, including near the summit beds of sandstone with *Scolithus*, and considered by Mr. Safford the equivalent of the Potsdam. (4th.) The Magnesian limestone and shale group, also several thousand feet thick, and divided into three parts; first a series of fucoidal sandstones approaching to slates and including bands of magnesian limestone; second, a group of many hundred feet of soft brownish, greenish, and buff shales, with beds of blue oolitic limestone, which as well as the shales, contain trilobites. Passing upward these limestones become interstratified with the third sub-division, consisting of heavy bedded magnesian limestone, more or less sparry and cherty near the summit. The limestones of Knoxville belong to this group, which with the 3d or Chilhowee group is designated by Mr. Safford as Cambrian, corresponding to the Primal and Auroral of Rogers, or to the Potsdam or Calciferous sandrock, with the possible addition of the Chazy, being equivalent to the great Magnesian limestone series of Prof. Swallow of Missouri. To these strata succeed Safford's 5th formation, consisting of limestones, the equivalents of the Black River, Trenton and higher portions of the Lower Silurian.

In Eastern Canada we find a group of strata similar to those described by Rogers and Safford, and distinguished by Sir William Logan as the Quebec group. It has for its base a series of black and blue shales, often yielding roofing slates, succeeded by grey sandstones and great beds of conglomerate, with dolomites and pure limestones, often concretionary and having the character of travertines. These are associated with beds of fossiliferous limestones, and with slates containing compound graptolites, and

are followed by a great thickness of red and green shales, often magnesian, and overlaid by 2000 feet of green and red sandstone, known as the Sillery sandstone, the whole from the base of the conglomerate, having a thickness about 7000 feet. These red and green shales resemble closely those at the top of the Hudson River group, and the succeeding sandstones are so much like those of the Oneida and Medina formations, that the Quebec group was for a long time regarded as belonging to the summit of the Lower Silurian series, the more so by a great break and upthrow to the S.E., the rocks of this group are made to overlap the Hudson River formation. "Sometimes it may overlie the overturned Utica formation, and in Vermont, points of the overturned Trenton appear occasionally to emerge from beneath the overlap."* This great dislocation is traceable in a gently curving line from near Lake Champlain to Quebec, passing just north of the fortress; thence it traverses the island of Orleans, leaving a band of higher strata on the northern part of the island, and after passing under the waters of the Gulf, again appears on the main land about eighty miles from the extremity of Gaspé, where on the north side of the break, we have as in the island of Orleans, a band of Utica or Hudson River strata. To the south and east of this line the rocks of the Quebec group are arranged in long, narrow, parallel, synclinal forms, with many overturn dips. These synclinals are separated by dark gray and black shales, with limestones, hitherto regarded as of the Hudson River age, but which are perhaps the deep-sea equivalent of the Potsdam.

The presence of conglomerates and sandstones, alternating with great masses of fine shales, indicates a period of frequent disturbances, with elevations and depressions of the ocean's bottom, while the deposits of dolomite, magnesite, travertine and highly metalliferous strata show the existence of shallow water, lagoons and springs over a great area and for a long period between the formation of the upper and lower shales. We may suppose that while the Potsdam sandstone was being deposited along the shores of the great palæozoic ocean, the lower black shales were accumulating in the deeper waters, after which an elevation took place, and the magnesian strata were deposited, followed by a subsidence during the period of the upper shales and Sillery sandstones.

Associated with the magnesian strata at Point Levi and in several other localities in the same horizon of the Quebec group, an extensive fauna is found, of which 137 species are now known, embracing more than 40 new species of graptolites, which have been described by Mr. James Hall in the report of

* See Sir William Logan's letter to Barrande, Canadian Naturalist for Jan. 1861. and this volume, 261.

the Geological Survey of Canada for 1857, and thirty-six species of trilobites described by Mr. Billings in the Canadian Naturalist for August, 1860. These species are as yet distinct from anything found in the Potsdam below or the Birdseye and Black River above; although the trilobites recall by their aspect those found by Owen in the Lower Sandstone of the Mississippi. Seven species alone out of this fauna have been identified with those known in other formations, and of these one is Chazy, while six belong to the Calciferous, to which latter horizon Mr. Billings considers the Quebec group to belong. The Chazy has not yet been identified in this region, unless indeed it be represented in some of the upper portions of the Quebec group. The Calciferous sandrock is wanting along the north side of the St. Lawrence valley from near Lake St. Peter to the Mingan Islands, but at Lorette behind Quebec, at the foot of the Laurentides, the Birdseye limestone is found reposing conformably upon the Potsdam sandstone.

It is not easy to find the exact horizon of the Potsdam sandstone among the black shales which underlie the Quebec group. The *Scolithus* of Rogers' Primal sandstone, and of the summit of Safford's 3d or Chilhowee formation is identical with that found in the quartz rock at the western base of the Green mountains, and figured by Mr. Hall in the 1st volume of the Palæontology. It is however distinct from what has been called *Scolithus* in the Potsdam of Canada. The value of this fossil as a means of identification is diminished by the fact that similar marks are found in sandstones of very different ages. Thus a *Scolithus* very like that of the St. Lawrence valley occurs in the sandstone of Lake Superior and in the Medina sandstone, while in Western Scotland, according to Mr. Salter, the two quartzite formations above and below the Lower Silurian limestones of Chazy age are alike characterized by these tubular markings, which are regarded by him as produced by annelids or sea-worms. We find however in shales which underlie the Quebec group at Georgia in Vermont, trilobites which were described by Mr. Hall in 1859 as belonging to the genus *Olenus*, a recognized primordial type; he has since erected them into a new genus. Again at Braintree in Eastern Massachusetts occur the well known *Paradoxyds* in an argillaceous slate. These latter fossils Mr. Hall suggests probably belong to the same horizon as certain slaty beds in the Potsdam sandstone, or perhaps even at the base of this formation. (Introduction, page 9.) In this connection we must recall the similar shales of Newfoundland, in which Salter has recognized trilobites of the same genus. These shales containing *Paradoxyds*, like those underlying the Quebec group, thus appear to belong to the Primordial zone, and are to be regarded as the equivalents of the Potsdam sandstone

which both in Lake Champlain and in the Mississippi valley is characterized by primordial types. The intermingling of Potsdam and Calciferous forms to which we have already alluded, seems however to show that it will be difficult to draw any well defined zoological horizon between the different portions of these lower rocks, which at the same time offer as yet no evidence of any fauna lower than that of the Potsdam. So that we regard the whole Quebec group with its underlying Primordial shales as the greatly developed representative of the Potsdam and Calciferous (with perhaps the Chazy), and the true base of the Silurian system.

The Quebec group with its underlying shales is no other than the Taconic system of Emmons. Distinct in its lithological characters from the Potsdam and Calciferous formations as developed on Lake Champlain, Mr. Emmons was led to regard these strata as belonging to a lower or sub-Silurian group. We have however shown that the palæontological evidence afforded by this formation gives no support to such a view. To Mr. Emmons is however undoubtedly due the merit of having for a long time maintained that the Taconic hills are composed of strata inferior to the Trenton limestones, brought up into their present position by a great dislocation, with an upthrow on the eastern side. We would not object to the term Taconic if used as indicating a subdivision of the Lower Silurian series, but as the name of a distinct and sub-Silurian system it can no longer be maintained. The Quebec group evidently increases in thickness as we proceed toward the south, and the calcareous parts of the formation are more developed. In 1859, I visited in company with Mr. A. D. Hager the marble quarries of Rutland and Dorset, in Vermont. The latter occur in a remarkable synclinal mountain of nearly horizontal strata of marble and dolomite, capped by shales, and attaining a height of 2700 feet above the railway station at its base. I then identified these marbles with the limestones of the Quebec group, considering them to be beds of chemically precipitated carbonate of lime or travertine, and not limestones of organic origin.

The existence of great dislocations in the Appalachian chain is amply illustrated in the sections of Prof. Rogers, and in those given by Safford in Eastern Tennessee, where by the aid of fossils it becomes comparatively easy to trace them. See the Map accompanying his *Geographical Reconnaisance of Tennessee*, 1855; where the magnesian limestones of formation IV, are shown to be not only brought up on the east against the Upper Silurian and Devonian, but even to overlap the black shales at the base of the Carboniferous system. It is remarkable to find that as early as 1822, the idea of a great dislocation of this nature in Eastern New York was maintained by Mr. D. H. Barnes in his description of Canaan mountain. (This Journal, [1], v, pp. 15–18).

in lithological character, but from actual sections, that the eastern

To the southeast of this great fault in Canada we have as yet no evidence of Lower Silurian strata higher than those of the Quebec group. At the eastern base of the Green mountains, we find limestones of upper Silurian and Devonian age reposing unconformably upon the altered strata of the Quebec group, themselves also having undergone more or less alteration. Immediately succeeding are the chiastolite and mica slates of Lake St. Francis, which as we have long since stated are probably also of Upper Silurian age.

The White mountains as we suggested in 1849, (this Journal, [2], ix, 19), are probably, in part at least, of Devonian age, and are the representatives of 7000 feet of Devonian sandstone observed by Sir William Logan in Gaspé. Mr. J. P. Lesley has more recently, after an examination of the White mountains, shown that they possess a synclinal structure, and has adduced many reasons for regarding them as of Devonian age. (Amer. Mining Journal, Jan. 1861, p. 99).

It will be seen from what has been previously said that we look upon the 1st and 2d divisions described by Mr. Safford in Eastern Tennessee, as corresponding to the hypozoic series of Rogers and to the Green mountain gneissic formation, which instead of being beneath the Silurian series, is really a portion of the Quebec group more or less metamorphosed, so that we recognize nothing in New England or southeastern Canada lower than the Silurian system, nor do we at present see any evidence of older strata, such as Laurentian or Huronian, in any part of the Appalachian chain. The general conclusions which we have previously expressed with regard to the lithological, chemical and mineral relations of the Green mountain rocks remain unchanged. (This Journal [2], ix, 12).

The remarkable parallelism between the rocks of Western Scotland and Canada has already been shown in the existence of the Laurentian, and Cambrian (Huronian) systems, overlaid by quartzites containing *Scolithus,* to which succeed limestones containing a numerous fauna, identified by Mr. Salter with that of the Chazy limestone. These strata, with an eastward dip, are covered by other quartzites and limestones, to which succeeds the great gneissoid formation of the western Highlands, consisting of feldspathic, chloritic, micaceous, and talcose schists resembling closely the gneissoid rocks of the Green mountains, and including the chromiferous ophiolites of Perthshire, Banff and the Shetland Isles.

This gneissoid series was by Prof. Nicol suggested to be the older or Laurentian gneiss brought up by a dislocation on the east of the Silurian limestones, but Sir Roderick Murchison, with Messrs. Ramsay and Harkness, has shown not only from the differences in lithological character, but from actual sections, that the eastern

gneissoid series is made up of altered strata newer than the Silurian limestones.* Thus in geological structure and age, not less than in lithological and mineralogical characters, the rocks of the western Highlands are the counterparts of the Laurentian and Silurian gneiss formations, as seen in the Laurentides and Adirondacks, and in the Green mountains. The same parallelism may be extended by Scandinavia, (where Kjerulf and Forbes have shown much of the crystalline gneiss to be of Silurian age,) marking as it would seem the outer edge of a vast Silurian basin, which may be followed in the other direction across the Atlantic to the Gulf of Mexico. We also remark in Great Britain as in America, that whereas the northern outcrop of the palæozoic basin offers at its base only a series of quartzose sandstones reposing upon the Laurentian system and characterized by fucoids and *Scolithus*, we find further south in England an immense development of shales, sandstones and conglomerates, which form the base of the Silurian system and correspond to the Primordial zone and the Quebec group.

We have said that upon Lake Huron and Superior the sandstones of the upper copper-bearing rocks are the equivalents of the Quebec group. The clear exposition of the question by Mr. J. D. Whitney in the Mining Journal for 1860 (p. 435) left little more to be said, but the sections made last year by Mr. Alex. Murray of the Canadian Geological Survey place the matter beyond all doubt. On Campment d'Ours, a small island near St. Joseph's, the sandstones of Sault St. Mary are seen reposing horizontally upon the upturned edges of the Huronian rocks, and overlaid by limestones which contain in abundance the fossils of the Black River and Birdseye divisions. The only fossil as yet found in these sandstones is a single *Lingula* from near Sault St. Mary, which may be either of Potsdam or Chazy age. The sandstones in question form the upper member of a series of strata which on Lake Superior attain a thickness of several thousand feet, and passing downwards we find a succession of limestones, marls and argillaceous sandstones, interstratified with greenstone and amygdaloid, and followed by about 2000 feet of bluish slates and sandstones, with cherty beds containing grains of anthracite, the whole underlaid by conglomerates, and reposing unconformably upon rocks of the Huronian system. The presence of such slates is the more significant from the occurrence already mentioned of fragments of green and black slates in the coarse grained sandstones near the base of the Potsdam, at Hemmingford mountain, showing the existence of argillaceous shales before the deposition of the quartzites of the Potsdam; these are more recent than the lowest shales of the

* Murchison, Quar. Jour. Geol. Society, vol. xv, 353 and xvi, 215.

Primordial zone, to which, however, palæontologically they appear to belong.

This Quebec group is of considerable economic interest inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, zinc, copper, silver, cobalt, nickel, chrome and titanium. I have long since called attention to the constant association of the latter metals, particularly chrome and nickel, with the ophiolites and magnesian rocks of this series, while they are wanting in similar rocks of Laurentian age. (This Journal, [2], xxvi, 237).

The immense deposits of copper ores in Eastern Tennessee, and the similar ones in Lower Canada, both of which are for the most part in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to have been preëminently the metalliferous period.

The metals of the Quebec group seem to have been originally brought to the surface in watery solution, from which we conceive them to have been separated by the reducing agency of organic matter in the form of sulphurets, or in the native state, and mingled with the contemporaneous sediments, where they occur in beds, in disseminated grains forming *fahlbands*, or as at Acton, are the cementing material of conglomerates. During the subsequent metamorphism of the strata these metallic matters being taken into solution by alkaline carbonates or sulphurets, have been redeposited in fissures in the metalliferous strata, forming veins, or ascending to higher beds, have given rise to metalliferous veins in strata not themselves metalliferous. Such we conceive to be in a few words the theory of metallic deposits; they belong to a period when the primal sediments were yet impregnated with metallic compounds which were soluble in the permeating waters. The metals of the sedimentary rocks are now however for the greater part in the form of insoluble sulphurets, so that we have only traces of them in a few mineral springs, which serve to show the agencies once at work in the sediments and waters of the earth's crust. The present occurrence of these metals in waters which are alkaline from the presence of carbonate of soda, is as we have elsewhere pointed out, of great significance when taken in connection with the metalliferous character of certain dolomites, which as we have shown probably owe their origin to the action of similar alkaline springs upon basins of sea water.

The intervention of intense heat, sublimation and similar hypotheses to explain the origin of metallic ores, we conceive to be uncalled for. The solvent powers of solutions of alkaline car-

bonates, chlorids and sulphurets at elevated temperatures, taken in connection with the notions above enunciated, and with De Senarmont's and Daubrée's beautiful experiments on the crystallization of certain mineral species in the moist way, will suffice to form the basis of a satisfactory theory of metallic deposits.*

The sediments of the carboniferous period, like those of earlier formations, exhibit towards the east a great amount of coarse sediments, evidently derived from a wasting continent, and are nearly destitute of calcareous beds. In Nova Scotia Sir William Logan found by eareful measurement, 14,000 feet of carboniferous strata; and Professor Rogers gives their thickness in Pennsylvania as 8000 feet, including at the base 1400 feet of conglomerate, which disappears before reaching the Mississippi. In Missouri Prof. Swallow finds but 640 feet of carboniferous strata, and in Iowa their thickness is still less, the sediments composing them being at the same time of finer materials. In fact, as Mr. Hall remarks, throughout the whole palæozoic period we observe a greater accumulation and a coarser character of sediments along the line of the Appalachian chain, with a gradual thinning westward, and a deposition of finer and farther transported matter in that direction. To the west, as this shore-derived material diminishes in volume, the amount of calcareous matter rapidly augments. Mr. Hall concludes therefore that the coal-measure sediments were driven westward into an ocean, where there already existed a marine fauna. At length, the marine limestones predominating, the coal measures come to be of little importance, and we have a great limestone formation of marine origin, which in the Rocky Mountains and New Mexico occupies the horizon of the coal, and itself unaltered, rests on crystalline strata like those of the Appalachian range. In truth, Mr. Hall observes, the carboniferous limestone is one of the most extensive marine formations of the continent, and is characterized over a much greater area by its marine fauna than by its terrestrial vegetation.

"The accumulations of the coal period were the last that gave form and contour to the eastern side of our continent, from the Gulf of St. Lawrence to the Gulf of Mexico; and as we have shown that the great sedimentary deposits of successive periods have followed essentially the same course, parallel to the mountain ranges, we naturally inquire: What influence this accumulation has had upon the topography of our country, and whether the present line of mountain elevation from northeast and southwest is in any way connected with the original accumulation of sediments?" *Hall's Introduction*, p. 66.

The total thickness of the palæozoic strata along the Appalachian chain is about 40,000 feet, while the same formations in

* Quar. Jour. Geol. Soc., vol. xv, 580.

the Mississippi valley, including the carboniferous limestone, which is wanting in the east, have, according to Mr. Hall, a thickness of scarce 4000 feet.* In many places in this valley we find the Silurian formations exposed, exhibiting hills of 1000 feet, made of horizontal strata, with the Potsdam sandstone for their base, and capped by the Niagara limestone, while the same strata in the Appalachians would give them ten to sixteen times that thickness. Still, as Mr. Hall remarks, we have there no mountains of corresponding altitude, that is to say, none whose height, like those of the Mississippi valley, equals the actual vertical thickness of the strata comprising them. In the west there has been little or no disturbance, and the highest elevations mark essentially the aggregate thickness of the strata comprising them. In the disturbed regions of the east on the contrary, though we can prove that certain formations of known thickness are included in the mountains, the height of these is never equal to the aggregate amount of the formations. "We thus find that in a country not mountainous, the elevations correspond to the thickness of the strata, while in a mountainous country, where the strata are immensely thicker, the mouutain heights bear no comparative proportion to the thickness of the strata." "While the horizontal strata give their whole elevation to the highest parts of the plain, we find the same beds folded and contorted in the mountain region, and giving to the mountain elevations not one-sixth of their actual measurement."

Both in the east and west, the valleys exhibit the lower strata of the palæozoic series, and it is evident that had the eastern region been elevated without folding of the strata, so as to make the base of the series correspond nearly with the sea level, as in the Mississippi valley, the mountains exposed between these valleys, and including the whole palæozoic series, would have a height of 40,000 feet; so that the mountains evidently correspond to depressions of the surface, which have carried down the bottom rocks below the level at which we meet them in the valleys. In other words the synclinal structure of these mountains depends upon an actual subsidence of the strata along certain lines.

We have been taught to believe that mountains are produced by upheaval, folding and plication of the strata, and that from some unexplained cause these lines of elevation extend along

* In Michigan according to the late report of Prof. Winchell the total observed thickness of the strata from the top of the Sault St. Mary sandstones to the top of the carboniferous series is little over 1790 feet, divided as follows:—Trenton and Hudson River groups, 50 feet, Upper Silurian 185, Devonian 782, Carboniferous 700; of this last the true coal measures constitute 123 feet, including from 3 to 10 feet of workable bituminous and cannel coals, while near the base of the carboniferous series are found 169 feet of gypsiferous marls, which yield strong brine springs.

certain directions, gradually dying out on either side, and subsiding at the extremities. We have, however, here shown that the line of the Appalachian chain is the line of the greatest accumulation of sediments, and this great mountain barrier is due to original deposition of materials, and not to any subsequent forces breaking up or disturbing the strata of which it is composed."

We have given Mr. Hall's reasoning on this subject, for the most part in his own words, and with some detail, for we conceive that the views which he is here urging are of the highest importance to a correct understanding of the theory of mountains. In the last volume of this Journal ([2], xxx, 137,) will be found an allusion to the rival theories of upheaval and accumulation as applied to volcanic mountains, the discussion between which we conceive to be settled in favor of the latter theory by the reasonings and observations of Constant-Prevost, Scrope and Lyell. A similar view applied to mountain chains like those of the Alps, Pyrennees and Alleghanies, which are made up of aqueous sediments, has been imposed upon the world by the authority of Humboldt, Von Buch and Elie de Beaumont, with scarcely a protest. Buffon, it is true, when he explained the formations of continents by the slow accumulation of detritus beneath the ocean, conceived that the irregular action of the water would give rise to great banks or ridges of sediments, which when raised above the waves must assume the form of mountains, and later, in 1832, we find De Montlosier protesting against the elevation hypothesis of Von Buch, and maintaining that the great mountain chains of Europe are but the remnants of continental elevations which have been cut away by denudation, and that the foldings and inversions to be met with in the structure of mountains are to be looked upon only as local and accidental.

In 1856, Mr. J. P. Lesley published a little volume entitled *Coal and its Topography*, (12mo, pp. 224), in the second part of which he has in a few brilliant and profound chapters discussed the principles of topographical science with the pen of a master. Here he tells us that the mountain lies at the base of all topographical geology. Continents are but congeries of mountains, or rather the latter are but fragments of continents, separated by valleys which represent the absence or removal of mountain land (p. 126); and again "mountains terminate where the rocks thin out." (p. 144.)

The arrangement of the sedimentary strata of which mountains are composed may be either horizontal, synclinal, anticlinal or vertical, but from the greater action of diluvial forces upon anticlinals in disturbed strata it results that great mountain

chains are generally synclinal in their structure, being in fact but fragments of the upper portion of the earth's crust, lying in synclinals, and thus preserved from the destruction and translation which has exposed the lower strata in the anticlinal valleys, leaving the intermediate mountains capped with lower strata. The effects of those great and mysterious denuding forces which have so powerfully modified the surface of the globe become less apparent as we approach the equatorial regions, and accordingly we find that in the southern portion of the Appalachian chain many of the anticlinal folds have escaped erosion, and appear as hills of an anticlinal structure. The same thing is occasionally met with further north; thus Sutton mountain in Canada, lying between two anticlinal valleys, has an anticlinal centre, with two synclinals on its opposite slopes. Its form appears to result from three anticlinals, the middle of which has to a great extent escaped denudation.

The error of the prevailing ideas upon the nature of mountain chains may be traced to the notion that the disturbed condition of the strata was not only essential to the structure of a mountain, but an evidence of its having been formed by local upheaval, and the great merit of De Montlosier and Lesley, (the latter altogether independently,) is to have seen that the upheaval has been in all cases not local but continental, and that the disturbance so often seen in the strata is neither dependent upon elevation nor essential to the formation of a mountain. The synclinal structure of portions of the Alps, previously observed by Studer and others, has been beautifully illustrated by Ruskin in the fourth volume of his *Modern Painters*, and in a late review of Alpine geology we have endeavored to show that the Alps, *as a whole*, have likewise a synclinal structure. (Amer. Jour. Science, xxix, 118.)

Such was the state of the question when Mr. Hall came forward, bringing his great knowledge of the sedimentary formations of North America to bear upon the theory of continents and mountains. These were first advanced in his address delivered before the American Association for the Advancement of Science, as its president, at Montreal in August, 1857. This address was never published, but the author's views were brought forward in the first volume of his *Report on the Geology of Iowa*, p. 41, and with more detail in the introduction to the third volume of his *Palæontology of New York*, from which we have taken the abstract already given. He has shown that the difference between the geographical features of the eastern and central parts of North America is directly connected with the greater accumulation of sediment along the Appalachians. He has further shown that so far from local elevation being concerned in the formation of these mountains, the strata which

form their base are to be found beneath their foundations at a much lower horizon than in the undisturbed hills of the Mississippi valley, and that to this depression, chiefly, is due the fact that the mountains of the Appalachian range do not, like those hills, exhibit in their vertical height above the sea the whole accumulated thickness of the palæozoic strata which lie buried beneath their summits.

Mr. Hall has made a beautiful application of these views to explain the fact of the height of the Green mountains over the Laurentides, and of the White mountains over the former, by remarking that we have successively the Lower and Upper Silurian strata superimposed on those of the Laurentian system. The same thing is strikingly shown in the fact that the higher mountain chains of the globe are composed of newer formations, and that the summits of the Alps are probably altered sediments of tertiary age. (This Journal, xxix, 118.)

The lines of mountain elevation of De Beaumont are according to Hall, simply those of original accumulations, which took place along current or shore lines, and have subsequently, by continental elevations, produced mountain chains. They were not then due to a later action upon the earth's crust, "but the course of the chain and the source of the materials were predetermined by forces in operation long anterior to the existence of the mountains or of the continent of which they form a part." p. 86.

It will be seen from what we have said of Buffon, De Montlosier and Lesley that many of the views of Mr. Hall are not new but old; it was, however, reserved to him to complete the theory and give to the world a rational system of orographic geology. He modestly says, "I believe I have controverted no established fact or principle beyond that of denying an influence of local elevating forces, and the intrusion of ancient or plutonic formations beneath the lines of mountains, as ordinarily understood and advocated. In this I believe I am only going back to the views which were long since entertained by geologists relative to continental elevations." p. 82.

The nature of the palæozoic sediments of North America clearly show that they were accumulated during a slow progressive subsidence of the ocean's bed, lasting through the palæozoic period, and this subsidence which would be greatest along the line of greatest accumulation, was doubtless, as Mr. Hall considers, connected with the transfer of sediment and the variations of local pressure acting upon the yielding crust of the earth, agreeably to the view of Sir John Herschel. The subsidence of the ocean's bottom would, according to Mr. Hall, cause plications in the soft and yielding strata. Lyell had already in speculating upon the results of a cooling and contracting sea of

molten matter, such as he imagined might have once underlaid the Appalachians, suggested that the incumbent flexible strata, collapsing in obedience to gravity would be forced, if this contraction took place along narrow and parallel zones of country, to fold into a smaller space as they conformed to the circumference of a smaller arc, "thus enabling the force of gravity, though originally exerted vertically, to bend and squeeze the rocks as if they had been subjected to lateral pressure.*

Admitting thus Herschel's theory of subsidence and Lyell's of plication, Mr. Hall proceeds to inquire into the great system of foldings presented by the Appalachians. The sinking along the line of greatest accumulation produces a vast synclinal, which is that of the mountain ranges, and the result of such a sinking of flexible beds will be the production within the greater synclinal of numerous smaller synclinal and anticlinal axes, which must gradually decline toward the margin of the great synclinal axis. This process the author observes appears to furnish a satisfactory explanation of the difference of slope on the two sides of the Appalachian anticlinals, where the dips on one side are uniformly steeper than on the other. p. 71.

An important question here arises, which is this;—while admitting with Lyell and Hall that parallel foldings may be the result of the subsidence which accompanied the deposition of the Appalachian sediments, we inquire whether the cause is adequate to produce these vast and repeated flexures, presented by the Alleghanies. Mr. Billings in a recent paper in the *Canadian Naturalist* (Jan. 1860), has endeavored to show that the foldings thus produced must be insignificant when compared with the great undulations of strata, whose origin Prof. Rogers has endeavored to explain by his theory of earthquake waves propagated through the igneous fluid mass of the globe, and rolling up the flexible crust. We shall not stop to discuss this theory, but call attention to another agency hitherto overlooked, which must also cause contraction and folding of the strata, and to which we have already alluded (Am. Jour. Sci. [2], xxx, 138). It is the condensation which must take place when porous sediments are converted into crystalline rocks like gneiss and mica slate, and still more when the elements of these sediments are changed into minerals of high specific gravity, such as pyroxene, garnet, epidote, staurotide, chaistolite and chloritoid. This contraction can only take place when the sediments have become deeply buried and are undergoing metamorphism, and is, as many attendant phenomena indicate, connected with a softened and yielding condition of the lower strata.

We have now in this connection to consider the hypothesis which ascribes the corrugation of portions of the earth's crust to

* Travels in N. America, 1st visit, vol. i, p. 78.

the gradual contraction of the interior. An able discussion of this view will be found in the American Journal of Science [2] iii, 176, from the pen of Mr. J. D. Dana, who, in common with all others who have hitherto written on the subject, adopts the notion of the igneous fluidity of the earth's interior.

We have however elsewhere given our reasons for accepting the conclusion of Hopkins and Hennessy that the earth, instead of being a liquid mass covered with a thin crust, is essentially solid to a great depth, if not indeed to the centre, so that the volcanic and igneous phenomena generally ascribed to a fluid nucleus have their seat as Keferstein and after him Sir John Herschel long since suggested, not in the anhydrous solid unstratified nucleus, but in the deeply buried layers of aqueous sediments which, permeated with water, and raised to a high temperature, become reduced to a state of more or less complete igneo-aqueous fusion. So that beneath the outer crust of sediments, and surrounding the solid nucleus we may suppose a zone of plastic sedimentary material, adequate to explain all the phenomena hitherto ascribed to a fluid nucleus. (Quar. Jour. Geol. Society, Nov. 1859. Canadian Naturalist, Dec. 1859, and Amer. Jour. Sci. [2,] xxx, 136).

This hypothesis, as we have endeavored to show, is not only completely conformable with what we know of the behavior of aqueous sediments impregnated with water and exposed to a high temperature, but offers a ready explanation of all of the phenomena of volcanos and igneous rocks, while avoiding the many difficulties which beset the hypothesis of a nuclens in a state of igneous fluidity. At the same time any changes in volume resulting from the contraction of the nucleus would affect the outer crust through the medium of the more or less plastic zone of sediments, precisely as if the whole interior of the globe were in a liquid state.

The accumulation of a great thickness of sediment along a given line would by destroying the equilibrium of pressure cause the somewhat flexible crust to subside; the lower strata becoming altered by the ascending heat of the nucleus would crystallize and contract, and plications would thus be determined parallel to the line of deposition. These foldings, not less than the softening of the bottom strata, establish lines of weakness or of least resistance in the earth's crust, and thus determine the contraction which results from the cooling of the globe to exhibit itself in those regions and along those lines where the ocean's bed is subsiding beneath the accumulating sediments. Hence we conceive that the subsidence invoked by Mr. Hall, although not the sole nor even the principle cause of the corrugations of the strata, is the one which determines their position and direction, by making the effects produced by the contraction, not only

of sediments, but of the earth's nucleus itself, to be exerted along the lines of greatest accumulation.

It will readily be seen that the lateral pressure which is brought to bear upon the strata of an elongated basin by the contraction of the globe, would cause the folds on either side to incline to the margin of the basin, and hence we find along the Appalachians, which occupy the western side of such a great synclinal, the steeper slopes, the overturn dips or folded flexures, and the overlaps from dislocation are to the westward, so that the general dip of the strata is to the centre of the basin, on the other side of which we might expect to find the reverse order of dips prevailing. The apparent exceptions to this order of upthrows to the southeast in the Appalachians appear to be due to small downthrows to the southeast, parallel to and immediately to the northwest of great upheavals in the same direction.

Mr. Hall adopts the theory of metamorphism which we have expounded in the pages of this Journal and in the paper just quoted above, (see also Am. Jour. Sci. [2,] xxv, 287, 435, xxx, 135), which has received a strong confirmation from the late researches of Daubrée. According to this view, which is essentially that put forward by Herschel and Babbage, these changes have been effected in deeply buried sediments by chemical reactions, which we have endeavored to explain, so that metamorphism, like folding, takes place along the lines of great accumulation. The appearance at the surface of the altered strata is the evidence of a considerable denudation. It is probable that the gneissic rocks of Lower Silurian age in North America were at the time of their crystallization overlaid by the whole of the palæozoic strata, while the metamorphism of carboniferous strata in eastern New England points to the former existence of great deposits of newer and overlying deposits, which were subsequently swept away.

On the subject of igneous rocks and volcanic phenomena, Mr. Hall insists upon the principles which we were, so far as we know, the first to point out, namely their connection with great accumulations of sediment, and of active volcanos with the newer deposits. We have elsewhere said: "the volcanic phenomena of the present day appear, so far as we are aware, to be confined to regions of newer secondary and tertiary deposits, which we may suppose the central heat to be still penetrating, (as shown by Mr. Babbage), a process which has long since ceased in the palæozoic regions." To the accumulation of sediments then we referred both modern volcanos and ancient plutonic rocks; these latter, like lavas, we regard in all cases as but altered and displaced sediments, for which reason we have called them exotic rocks. (Am. Jour. Sci. [2,] xxx, 133). Mr. Hall reiterates these

views, and calls attention moreover to the fact that the greatest outbursts of igneous rock in the various formations appear to be in all cases connected with rapid accumulation over limited areas, causing perhaps disruptions of the crust, through which the semi-fluid stratum may have risen to the surface. He cites in this connection the traps with the palæozoic sandstones of Lake Superior, and with the mesozoic sandstones of Nova Scotia and the Connecticut and Hudson valleys.

It may sometimes happen that the displaced and liquified substratum will find vent, not along the line of greatest accumulation, but along the outskirts of the basin. Thus in eastern Canada it is not along the chain of the Notre Dame mountains, but on the northwest side of it that we meet with the great outbursts of trachyte and dolerite, whose composition and distribution we have elsewhere described. (Report of Geological Survey for 1858, and Am. Jour. Science, [2,] xxix, 285).

The North American continent, from the grand simplicity of its geological structure, and from the absence, over great areas, of the more recent formations, offers peculiar facilities for the solution of some of the great problems of geology; and we cannot finish this article without congratulating ourselves upon the great progress in this direction which has been made within the last few years by the labors of American geologists.

Montreal, March 1st, 1861.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

PHYSICS.

1. *On Regelation.*—In the year 1850, Prof. Faraday directed the attention of scientists to the remarkable fact that two pieces of moist ice when placed in contact will unite, even when the surrounding temperature is above 0° C. To the phenomenon in question the term "regelation," has been applied by Tyndall, who has made the fact above mentioned the basis of a theory of the plasticity of ice, in accounting for the descent of glaciers. Several theories have been advanced to explain the facts of regelation. Faraday* explained it by assuming that a particle of water can retain its fluid condition only when in contact with ice on one side, but freezes when touched by ice on both sides, the general temperature remaining the same. This explanation—with all deference be it said—is simply a re-statement of the fact and not an assignment of a physical cause. Person maintains that the solution of ice is a *gradual* process, the ice passing through intermediate states of viscosity to the condition of a liquid. He considers ice as essentially colder than the water in contact with it; that a film of plastic ice or viscid water lies between the ice and the water, and that heat is constantly passing from the water to

* Researches in Chemistry and Physics, pp. 373, 378.

the ice through this film. The water therefore becomes colder and finally freezes. This view is adopted by Prof. J. D. Forbes.* Neither Person nor Forbes explain why a thin film of water in contact with a mass of ice has or can have any other temperature than the ice itself, nor why water at 0° should give off heat to ice at 0°. Prof. James Thomson's theory† is in his own words as follows: If to a mass of ice at its melting point, pressures tending to change its form be applied, there will be a continual succession of pressures applied to particular parts—liquefaction occurring in these parts through the lowering of the melting-points by pressure—evolution of the cold (*sic*) by which the so melted portions had been held in the frozen state—dispersion of the water so produced in such directions as will afford relief to the pressure—and recongelation by the cold previously evolved, of the water on its being relieved from this pressure: the cycle of operations will then begin again; for the parts re-congealed, after having been melted, must in their turn, through the yielding of other parts, receive pressures from the applied forces, thereby to be again liquefied and to proceed through successive operations as before. This theory certainly appears to be tenable in the case of glaciers, or wherever great pressures are applied, as in the moulding of ice under a hydrostatic press, but its application is to say the least, doubtful in the case of simple contact between small masses of ice. Moreover Faraday has shown that pressure is not necessary in regelation. Of the numerous experiments which he has instituted the following appears to us the most convincing. Two round cakes of ice, convex upon the upper surfaces, are placed in water of ordinary temperature and then sunk beneath the surface by little weights of wax or spermaceti. Two such pieces of ice touching each other gently at a single point freeze together. In this case no sensible capillary action takes place in consequence of the figures of the masses of ice. Faraday did not succeed in obtaining regelation with melted bismuth, tin and lead, nor with glacial acetic acid, or saline bodies. He considers the phenomenon therefore as peculiar to water. W. G.

2. *On the changes produced in the position of the fixed lines in the spectrum of hyponitric acid by changes in density.*—Weiss has found by actual measurement that the distance between the dark lines in the spectrum of hyponitric acid diminishes as the density of the gas increases. The measurements were made with an Oertling's circle reading directly to two seconds of arc and, by a filar micrometer in the ocular, to a single second. The same phenomenon occurs with the spectrum of chlorophyll. The stronger the extract in ether the less is the distance of the absorption bands. Thus the absorption-band in the red in the case of a strong extract corresponds quite well with Fraunhofer's line C; in the case of a weak extract it stands at some distance from it. The other absorption-bands in this spectrum undergo similar dislocations.

These changes in the distances of the dark lines are very sensible even in the spectrum of hyponitric acid, when the changes in the density of the gas are considerable; they are not however equal for all the dark lines.

* Proceedings of the Royal Society of Edinburgh, April 19th, 1858.

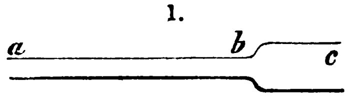
† Royal Society Proceedings, vol. x, p. 152.

The cause of these dislocations is to be sought, according to Weiss, in a one-sided absorption which each line undergoes toward the violet end of the spectrum, when the density of the body is increased. This is shown by direct observations and comparisons with the solar spectrum as well as by numerous measurements. There is no specific absorption upon both sides of each line, but only an absorption upon the side of the line which lies toward the violet end of the spectrum. In this manner the bands become broader and the distance between them less. The author has observed similar changes in the breadth of Fraunhofer's lines at sunset. In this case also the absorption was only upon one side. From this it appears that the lines of hyponitric acid cannot be used as standards in determinations of indices, &c.—*Pogg. Ann.*, cxii, p. 153, Jan. 1861. W. G.

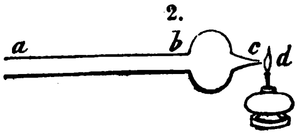
3. *Note on Dr. J. LeConte's Paper* (*on the influence of Musical Sounds on the flame of a jet of Coal Gas*, [This Jour. [2], xxv, 62]), *with an experiment by Dr. Charles Sondhauss*, Director of the Realschule of Neisse, (in a letter to Dr. William Sharswood).—"The observation of your friend Dr. LeConte is very interesting, although I must beg leave to differ from his theory of "molecular cohesion," or attraction between the particles of an aeriform body, particularly at the high temperature of flame. Such an hypothesis, however, seems to me unnecessary as an explanation of the phenomenon; nor does this theory demonstrate that the gas-flame is a body different from air:—in which case the flame would be removed from the external tendency to oscillation, and by its own oscillation would even bring the surrounding air or gas column into a state of fluctuation and singing, as in the case of the chemical harmonicon.

Thus a flame operates to surround and hold together the gas column as a separate body. This becomes quite evident from the following experiment which I have devised.

1.



2.



I employ a glass tube of the following form, fig. 1, or fig. 2, which is open at both ends. Half of the opening (*c*), is placed close to a small flame of an alcohol lamp, (*d*): with the mouth fixed at (*a*), I blow a slow current of air, when there is produced a loud whistling tone, the pitch of which is governed by the dimensions of the apparatus, as well as by the force with which the current of air is produced. The dimensions of the glass tube used by me, are, 150–240 centimetres long, the opening at (*c*), 2–5 millimetres wide, and the diameter of the cylinder or spherical enlargement (*b, c*), amounts to 1·5–2·2 ctm.

If we blow a current of air through such a glass tube, without employing the flame as above, there will be produced only a roaring sound, in which there is perceived a tendency to the production of such a tone."

Note by Dr. Sharswood.—To those physicists, who may be inclined to take up the investigation of singing flames, etc., I would suggest, that, the phenomena may be most conveniently produced, by sounding two imperfect intervals in unison, on the flageolet. By two imperfect intervals in unison, I mean two-thirds in unison, one tuned a little flat of the other.

I subjoin a list of the contributions to Acoustics by Dr. Sondhauss. They have been mostly published as Programmes, and are therefore not generally accessible in this country.*

4. *Color of Blood Globules.—Editorial Note to Dr. Reuben's paper*, p. 328.—With regard to the color of single blood globules, it must be admitted that when individual blood globules are viewed under a magnifying power of from 600 to 800 diam., they certainly appear colored distinctly *yellow*, and not red. If now one or two plates of cobalt glass be placed under the stage, or over the eye-piece, the blood globules by virtue of their yellow tint, actually do cut off much of this blue light, probably not less than 50 or 60 per cent. They then appear much darker than the general field; their tint at first sight seems simply dark grey, attentive examination shows it to be dark bluish-green.

Compare also Herschel on the change of tint by an increase of thickness. Herschel on Light, Sect. 495.

In the 8th No. of the *Allgemeine Encyklopædie der Physik*, (Dec. 1860), HELMHOLTZ details some observations of Purkinje on this subject, which agree with those of Prof. Wm. B. Rogers already published in this Journal. Helmholtz seems in doubt whether to attribute this appearance (seen with the naked eye,) to the flow of blood globules or to some other cause. He adds, "If this appearance has actually a connection with the circulation of the blood, we can admit at the most only, that single lymph corpuscles rich in fat and passing through some of the larger vessels, become visible in this manner."

5. *Subjective Optical Phenomena.*—In the London and Edinburgh Phil. Magazine, Jan. 1861, SIR DAVID BREWSTER gives a short account of some optical experiments of a subjective nature. A blackened card provided with slits was moved rapidly before a circular aperture in the window shutter of a dark room; the aperture appeared then colored; reckoning from the centre, white or bluish, darker blue, white, dark ring, white, greenish yellow, reddish. It is unfortunate that neither he nor other observers have detailed the rates of motion they communicated to the slits, so as to render a comparison of observations possible. I infer from a slight repetition of these experiments that the rates were much lower than those employed by me. See No. 90 of this Journal, 1860.

He found also when the luminous impressions succeeded each other at a certain (long or short?) interval, that a hexagonal pattern was plainly visible. Compare a similar observation of *Purkinje*† under the same circumstances. Streams of moving particles have also been observed, and have been ascribed by Vierordt, to the blood circulation in the retina, becoming momentarily visible.† I have often caught distinct glimpses of this appearance. O. N. R.

* (I.) Ueber die Schallschwingungen der Luft in erhitzten Glassröhern und in gedeckten Pfeifen von ungleicher Weite.—Ann. ch. u. Ph. lxxix, pp. 1-34.

(II.) Ueber den Brummkreisel und das Schwingungsgesetz der trobischen Pfeifen, —Jahresbericht K. Kath. Gymnasiums Breslau, 1850, pp. 3-37.

(III.) Ueber die beim Auströmen der Luft entstehenden Töne.—Programme der Realschule zu Neisse, 1853, pp. 1-31, reprinted in Ann. ch. u. Ph. xci, p. 129, et infra.

(IV.) Ueber die Chemische Harmonika.—Programm der Realschule zu Neisse, 1859, pp. 1-43. (A very learned and full resume, together with valuable contributions to the subject).

† *Physiologische Optik*, by H. Helmholtz, 1860, page 381.

6. *On some illusions, and other phenomena, attendant on vision through colored media;* by SIMON NEWCOMB.—(1.) Let one put a red glass over the right eye, pressing it in so closely that little or no light can get to the eye except through the glass, hold a green or blue one over the left eye in the same manner, and thus look at surrounding objects in general for a few minutes. On removing the glass he will find that white objects will appear greenish when observed with the right eye alone, and reddish, or tinged with orange, when viewed with the left eye alone.

Evidently this illusion must be one of *sensation*, and not one merely of *judgment;* the term illusion (or error) of sensation, being applied to the case in which the impression actually conveyed to the mind is different from that ordinarily conveyed by the same exciting cause; and the term illusion or error of judgment to the case in which the mind forms an erroneous opinion respecting the nature of the impession. We are frequently, though not always, able to refer an observed illusion to one or the other of these two classes. Thus, in the case of the apparent enlargement of the celestial bodies when near the horizon, it is well known that the illusion is not in the impression of magnitude actually conveyed by the optic nerve to the brain, but that the mind, from a well known cause forms an erroneous judgment respecting the apparent magnitude. The above mentioned illusion resulting from observation through colored media is evidently one of sensation, because, the mind which judges being singular, would form the same sort of erroneous opinion respecting a sensation transmitted by one eye that it would respecting a similar sensation transmitted by the other. The glasses may be held so that it will be impossible for the observer to say which eye is covered by the red glass and which by the green one; yet on removing the glasses he can speedily solve the question by shutting the eyes alternately.

This phenomenon may be accounted for on the general principle that the increase of sensibility of the eye when placed for some time in darkness takes place independently with respect to the several colors of light; so that an eye from which all the red light is excluded will become sensitive to red light with equal rapidity whether light of other colors is admitted or excluded.

[This is analogous to the experiment of Count Schoffgotsch. His diploscope consists of a rotating disc painted half green, half red, and is observed through two tubes held before the two eyes. One eye becomes fatigued by the green light, the other by the red; if now the disc is set in rotation, the first eye sees only red, the other only green light. (See Eisenlohr, *Physik*, p. 327.)]

2. The two following experiments illustrate very finely the doctrine of corresponding retina points, and the inability of the eye to distinguish the organ by which observed sensation is conveyed.

With the glasses arranged as already mentioned look at a piece of white paper, having on it two spots, one of a very bright red, and the other of a very bright and pure green or greenish blue. If the left eye be closed the green spot will appear entirely black, while the red spot will appear so nearly of the general color of the paper as to be scarcely visible, and will not present the faintest indication of being red. If the right eye be closed the red spot will seem black, and the green spot will appear of

the color of the paper; but if both eyes be open, the spots will both appear of their natural color.

Under the same circumstances look at a white spot of paper with a single black spot on it. The spot will of course appear black, while the paper will be of those uncertain, mixed and ever varying shades which we know to be the result of looking at white objects in this manner. But, let the paper be now brought so close to the eye that two images of the spot may be seen. Instead of one or both images seeming black, that which corresponds to the black image as seen through the red glass will be of a bright green, while the other will be of a bright red. This is the result we ought to expect. To fix the ideas, and avoid troublesome phrases, let I represent the portion of the right retina on which the image of the spot falls, and I′ the corresponding portion of the left retina. Let J′ represent the portion of the retina of the left eye on which the image falls, and J the corresponding portion of the right retina. Call E and E′ all those portions of the respective retinas except L+I, and J+J′. Then the mind can make no distinction between the impression conveyed by L, and that conveyed by L′, and so of the other portions. From the arrangement of the glasses we have

On E red light,	on E′ green light;	result, an uncertain white.
On I darkness,	on I′ green light;	result, green.
On J red light,	on J′ darkness;	result, red.

These results correspond with the observed phenomena. It will be observed that the greenness of the apparent image of the spot seen by the right eye proceeds from the green light which falls on the corresponding point of the left eye, where it is not neutralized by the red light of the right eye. The result of the previous experiment is to be explained in a similar manner. [Compare Dove's experiment of looking at a green pattern on a red ground through red and green glasses. This vol., p. 109].

3. Suppose now that the green glass is removed, the eyes still observing a double image. It might then be supposed that the red image would preserve its color, since the nature of the light falling on the portions J, J′, of the retinas is not changed; and that the other image would lose all coloration, since it is now produced by white light on the one retina and darkness on the other. But the real result will be singularly the converse of this. The first image will lose nearly every trace of red, appearing almost perfectly black, while the second one will preserve its apparent greenness in all its brilliancy, though not a particle of green light (except what helps to form white,) can reach either eye! Vice versa, if the red glass be removed, the green image will change to black, while the red one will preserve its apparent color.

[No. 3 may be explained by the well known fact that when we look at an object placed so near the eyes that a double image is seen, the right image belongs to the left eye, and vice versa; also that a black object on a red field soon assumes a green tint, and *v. v.*]

CHEMISTRY.—

7. *Researches on the mutual relations of the Equivalents.*—With this title J. S. STAS has communicated the results of a ten years' laborious investigation, devoted specially to the examination of Prout's often dis-

cussed hypothesis. The memoir in question is one of extraordinary thoroughness and detail, which requires to be carefully studied, and does not admit of an abstract. Full details are given of the balances employed, of the methods of purification and analysis made use of; of the vessels used and the changes which they undergo; in short of all the precautions required to render the results as free as possible from errors of observation.

The result of this immense and conscientious labor is that *there is no common divisor* for the equivalents of the elements. In his own words, the author has attained "the full conviction, and so far as is humanly possible the perfect certainty, that Prout's law, together with the modifications introduced by Dumas, is nothing but a deception, a pure hypothesis."

The equivalents deduced by Stas are as follows:

Potassium,	39·154	from the decomposition of the chlorate.
Sodium,	23·05	
Ammonium,	18·06	
Silver,	107·94	
Lead,	103·45	from the synthesis of the sulphate.
"	103·46	" " " " nitrate.
Chlorine,	35·46	
Nitrogen,	14·04	
Sulphur,	16·03	

Berzelius found for potassium 39·150; Pelouze 39·156, and Marignac 39·161. By comparing the equivalents of ammonium and nitrogen in the table it will be seen that the difference is 4·02 instead of 4·00. As the equivalent of nitrogen was deduced from the synthesis of nitrate of silver, it follows either that this is inaccurate, or that the equivalent of hydrogen is inaccurate by the $\frac{1}{200}$ of its value. Stas considers the last as probable, and proposes to institute a new investigation of the composition of water.—*Recherches sur les rapports réciprociques des poids atomiques, Brux.* 1860, quoted in *Jour. für prakt. Chemie*, 29, p. 65, No. 2, 1861.

W. G.

8. *On the polyatomic bases of the nitrogen, phosphorus and arsenic series.*—A. W. Hofmann has given some general views on the structure of the ammonia-derivatives which will serve as a useful guide in the study of the immense number and variety of new bases with which he has enriched the science. When dibromid of ethylene $C_4H_4Br_2$ reacts with a monamin, as for example with ammonia, either one or two molecules of the latter are fixed and there result two series of salts, one of which is monatomic and the other diatomic, and the composition of which is expressed in the following formulas:

I. Diatomic series. II. Monatomic series.

$$\left.\begin{array}{l} [(C_4H_4)'' \, H_6N_2]''Br_2 \\ [(C_4H_4)''_2H_4N_2]''Br_2 \\ [(C_4H_4)''_3H_2N_2]''Br_2 \\ [(C_4H_4)''_4 \quad N_2]''Br_2 \end{array}\right\} \text{Ethylene bases.} \qquad \left.\begin{array}{l} [(C_4H_4Br) \, H_3N]Br \\ [(C_4H_4Br)_2H_2N]Br \\ [(C_4H_4Br)_3H \, N]Br \\ [(C_4H_4Br)_4 \quad N]Br \end{array}\right\} \text{Bromethyl bases.}$$

In the salts of the second series bromine may be eliminated either wholly or partially as bromhydric acid, formed either at the expense of water present—in which case the atomic group HO_2 replaces bromine—

or at the expense of ethylene itself, in which case vinyl compounds are produced. Two new groups are formed in this manner which may be formulated as follows:

III. Oxethyl bases.	IV. Vinyl bases.
$[(C_4H_4HO_2)\ H_3N]Br$	$[(C_4H_3)\ H_3N]Br$
$[(C_4H_4HO_2)_2H_2N]Br$	$[(C_4H_3)_2H_2N]Br$
$[(C_4H_4HO_2)_3H\ N]Br$	$[(C_4H_3)_3H\ N]Br$
$[(C_4H_4HO_2)_4\ \ N]Br$	$[(C_4H_3)_4\ \ N]Br$

From this it appears that the action of dibromid of ethylene upon ammonia produces sixteen bases, independently of intermediate and secondary products. The reactions are however much simpler with primary, secondary and tertiary monamins, the first class giving twelve, the second eight, and the third four bases. The author obtained the clearest expression of his theoretical views by operating upon triethylamin, triethylphosphin and triethylarsen. When these alkaloids are treated with dibromid of ethylene the following three groups of compounds are formed:

Nitrogen group.	Phosphorus group.	Arsenic group.
$[(C_4H_4)''(C_4H_5)_3N_2]''Br_2$.	$[(C_4H_4)''(C_4H_5)_6P_2]''Br_2$.	$[(C_4H_4)''(C_4H_5)_6As_2]''Br_2$

II. *Bromoethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_4Br)(C_4H_5)_3N]Br$.	$[(C_4H_4Br)(C_4H_5)_3P]Br$.	$[(C_4H_4Br)(C_4H_5)_3As]Br$

III. *Oxethyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_5O_2)(C_4H_5)_3N]Br$.	$[(C_4H_5O_2)(C_4H_5)_3P]Br$.	$[(C_4H_5O_2)(C_4H_5)_3As]Br$

IV. *Vinyl-triethylized salts.*

Nitrogen series.	Phosphorus series.	Arsenic series.
$[(C_4H_3)(C_4H_5)_3N]Br$.	$[(C_4H_3)(C_4H_5)_3P]Br$.	$[(C_4H_3)(C_4H_5)_3As]Br$

The bodies belonging to the second group, in the presence of other substances, yield very elegant reactions. Treatment with monamines, monophosphines, and monarsines transform them into an inexhaustible group of diammonium, diphosphonium, and diarsonium compounds on the one hand, and of phosammonium, phospharsonium, and arsammonium salts on the other. Polyatomic bases of a higher order result from the action of the diamines—ethylene diamines for instance—upon the bromo-ethylized salts.

The derivation of the oxethyl from the bromo-ethyl salts has already been mentioned. We have, for example, the equation:

$$[(C_4H_4Br)(C_4H_5)_3P]Br+H_2O_2=BH+[(C_4H_4HO_2)(C_4H_5)_3P]Br.$$

The new salt bears the same relation to the bromo-ethyl salt which alcohol bears to bromid of ethyl. Hence, as might be expected, the oxethyl salt may be converted into the bromo-ethyl salt by distillation with pentabromid of phosphorus.

$$[C_4H_4HO_2)(C_4H_5)_3P]Br+PBr_5=PO_2Br_3+HCl+[(C_4H_4Br)(C_4H_5)_3P]Br.$$

The bromo-ethyl bromids may be regarded as tetrethyl compounds in which a molecule of ethyl has been converted into bromo-ethyl. Nascent hydrogen converts the bromo-ethylized bromids into tetrethyl bromids. Thus we have:

$$[(C_4H_4HBr)(C_4H_5)_3P]Br + 2H = HBr + [(C_4H_4)_4P]Br.$$

In conclusion the author points out the possibility of obtaining triatomic, tetratomic and pentatomic bases, either by the action of ammonia upon more highly brominated bromo-ethyl bases or by the same action upon bases containing two, three or four equivalents of bromo-ethyl. Thus we might have the reactions indicated by the equations

$$[(C_4H_3Br_2)H_3N]Br + 2H_3N = [(C_4H_3)'''H_9N_3]'''Br_3.$$
$$[(C_4H_2Br_3)H_3N]Br + 3H_3N = [(C_4H_2)^{iv}H_{12}N_4]''''Br_4.$$

. . . .

$$[(C_4H_4Br)_2H_2N]Br + 2NH_3 = [(C_4H_4)_2''H_8N_3]'''Br_3.$$
$$[(C_4H_4Br)_3HN]Br + 3NH_3 = [(C_4H_4)''_3H_{10}N_4]''''Br_4.$$
$$[(C_4H_4Br)_4N]Br + 4NH_3 = [(C_4H_4)''_4H_{12}N_5]'''''Br_5.$$

Hofmann has already obtained a series of triatomic bases, of which diethylentriamin may be regarded as especially worthy of notice. The base has the formula

$$C_8H_{13}N_3 = \left.\begin{matrix}(C_4H_4)''_2\\ H_5\end{matrix}\right\} N_3$$

and is the first triacid ammonia. It forms magnificent salts, the chlorid being

$$[(C_4H_4)''_2H_8N_3]Cl_3.$$

—*Journal für prakt. Chem.*, No. 2, 1861, p. 110, and *Sitzungsberichte der k. Preuss. Acad. zu Berlin*, Oct. 1860. W. G.

9. *On the cyanid of Ethylene.*—Succinic acid bears the same relation to glycol which propionic acid bears to alcohol. As cyanid of ethyl by boiling with hydrate of potash yields ammonia and propionate of potash, it might be expected that under the same circumstances cyanid of ethylene would yield succinate of potash. Simpson has found that this is the case. The cyanid of ethylene, as prepared by the action of bromid of ethylene upon cyanid of potassium, is a semifluid brown and crystalline mass; easily soluble in water and alcohol. When boiled for some time with an alcoholic solution of caustic potash, ammonia is given off and succinate of potash formed. The reaction is expressed by the equation

$$C_4H_4Cy_2 + 2KHO_2 + 4HO = C_8H_4K_2O_8 + 2NH_3.$$

—*Zeitschrift für Chemie und Pharmacie*, Heft. 1, 1861, p. 14. W. G.

10. *On the separation of Mono- Bi- and Triethylamin.*—When iodid of ethyl is heated with ammonia, as Hofmann long since showed, all three ethylated ammonias are formed and these are difficult to separate. Hofmann now finds that the separation is easily affected by adding oxalate of ethyl to the mixed bases. This converts the ethylamin into diethyl-oxamid $\left.\begin{matrix}C_4O_4\\ (C_4H_5)_2\\ H_2\end{matrix}\right\} N_2$; the diethylamin into diethyl-oxamate of ethyl $\left.\begin{matrix}C_4H_4\\ \left\{\begin{matrix}C_4O_5\\ (C_4H_5)_2N\end{matrix}\right\}\end{matrix}\right\} O_2$, but leaves the triethylamin unchanged. The diethyl-oxamid separates completely as a white crystalline powder while the other two remain fluid and are easily separated by filtration. These two

may then be separated by distillation, the triethylamin boiling at 91° C. and the ether at 260° C. The two oxamates may then be decomposed by caustic potash and yield the pure alkaloids.—*Zeitschift für Chemie und Pharmacie*, 1861, Heft. 1, 13. W. G.

TECHNICAL CHEMISTRY.

11. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (Concluded from p. 289.)

"One of the most common complaints against yellow-metal arises from a tendency which some specimens of it exhibit to become so friable, after an exposure of longer or shorter duration to sea-water, that the sheets may readily be broken in pieces, sometimes even between the fingers. Attention has recently been called to this subject by Bobierre,* who would refer such cases more particularly to chemical conditions depending, as he thinks, upon the too great proportion of zinc which is used in the preparation of the alloy, yellow-metal, as well as to changes of composition produced by hot rolling.

"I cannot agree with this conclusion. In my own opinion, the other alternative which Bobierre has suggested, namely, peculiar arrangement of the molecules of which the alloy is composed, furnishes the true explanation of the difficulty. It is, however, possible, that at times, when the temperature of the reverberatory, in which the alloy is heated before passing to the rolls, is not properly regulated, zinc may be burned off from the exterior portions of the sheet, and that the alloy richer in copper which would thus be formed may subsequently be pressed into the body of the sheet during the operation of rolling. An alloy destitute of homogeneity would result from this treatment which could hardly be durable in any event. Instances of this sort must nevertheless be rare, for no part of the process is watched by the manufacturers more scrupulously than this.

"It must also be borne in mind, that, of the enormous quantity of yellow-metal which is now used by the merchant vessels of Great Britain and of this country,—all of which is composed of sixty parts of copper and forty parts of zinc, and rolled hot, —only a comparatively small portion passes into the friable condition to which I have alluded.

"In most cases the alteration which the sheathing undergoes is gradual and regular, and the portion which remains after the wear of several years is still malleable. Indeed, the absolute amount of sheathing which becomes friable is entirely out of proportion with the annoyance to which it subjects ship-owners;† for it rarely happens, even in the worst instances, that more than one third of the sheets upon a vessel become friable, the remainder being in good condition.

"The friability is therefore a purely accidental occurrence, and by no means a necessary consequence either of hot rolling or of the presence of 40 per cent of zinc in the alloy, as has been implied by Bobierre.‡ I am strongly of opinion, that it might be in every instance entirely obviated by methodically annealing or tempering the sheets of alloy in such a manner that no fibres could form in them, and that their structure should be homogeneous.

"Bobierre in his very able thesis, to which I have already alluded, has urged that it would be well to discontinue the use of the alloy containing 60 per cent of copper, which admits of being rolled hot, and to substitute for it sheathing prepared from alloys containing about 66 per cent of copper, which can only be prepared by a most laborious process of cold rolling. It is true that the fibres which I have described would in this case probably never be encountered. Still there are several important

* Thèses presèntées à la Facultè des Sciences de Paris.
Thèse de Physique: Des Phénomenes électro-chimiques qui caractérisent l'Altération, à la Mer, des Alliages employés pour doubler les Navires. Nantes: Imp. Busseuil. 1858. p. 61.

† Whenever the destruction of a portion of the sheathing requires that a ship be hauled up for repairs, it is customary, since this operation is an expensive one, to resheathe the vessel entirely: for as the friable sheets are interspersed among the others, and since all the sheets are somewhat worn, it would be bad economy to attempt any partial repairs. Of course the owner of the vessel regards the entire suit of sheathing as being worn out, and forms his opinion of the durability of yellow-metal in accordance with this view.

‡ Thèses, p. 77.

objections to the proposition of M. Bobierre. Not only would the method of cold rolling consume a much greater amount of time and labor; but it would be exceedingly difficult, if not impossible, to procure any alloy the composition of which could be maintained so nearly constant as is the case with yellow-metal.* It is not probable that a test like the one applied to this alloy could be found anywhere else in the whole series

"It is frequently stated in chemical text-books that yellow-metal is always prepared from "best-selected" copper, and one is led to infer that a metal of peculiar purity is alone used in its manufacture. This may once have been the case; but since the immense increase in the use of this alloy, it would no longer be practicable to obtain a sufficient quantity of copper of uniform character, or indeed of any one kind, from which to prepare the large quantity of sheathing which is used. In an establishment where expense would be a secondary consideration, as, for example, in a government workshop, it might still be possible to prepare an alloy constantly from the same sorts of copper and of zinc, in which case, although the amount of zinc lost would probably be subject to considerable variations, one might, nevertheless, soon be able to control the process, and to prepare an alloy of the composition proposed by Bobierre, so that only trifling variations should occur in the composition of the product. But in ordinary practice manufacturers are compelled to make use of the most varied kinds of copper, not only because the supply of the best sorts is limited, but particularly from the fact, that, owing to the competition which exists between the various founderies,—or rather, by force of the laws which regulate supply and demand,—they are obliged to remelt large quantities of old copper sheathing,† the origin of which is unknown to them, and which may have been originally prepared from copper of inferior quality.

"Now since many of the impurities of copper are eliminated when it unites with zinc, being thrown up on the surface of the melted metal as a crust or scum which is removed by the workmen,‡ and as no two samples of copper contain the same kind or quantity of impurity, the amount of it removed, or, what is the same thing, the amount of copper left to unite with a given weight of zinc,§ must continually vary.

"From this it may easily be seen how very difficult, if not impracticable, it would be to obtain anything like constant results, unless some test were found by which the workman might ascertain at least approximately the composition of his alloy.‖

"That it is of the first importance that every alloy used for sheathing shall possess some one constant composition, so that it may endure equally well on all parts of the vessel, and that no voltaic action may occur between the metal of different sheets, is a point too obvious to be mentioned.

"It might still be urged against yellow-metal, that the admixture of other metals —of kinds capable of mingling with it—which may have been derived from the copper used in its preparation, is a serious objection to its use. This is true, and the remark applies with equal or even greater force to all the alloys used for sheathing; it must always depend upon the condition of copper metallurgy. It would apply more forcibly, for example, to the low grade brass which Bobierre has proposed to substitute for the ordinary sheathing metal; for since the "test" by means of which founders are enabled to prepare the alloy—yellow-metal—of constant composition

* An alloy of constant composition might, however, possibly be prepared, by adding known quantities of melted copper to determined volumes of molten yellow-metal which had been prepared by the usual method.

† The popular notion, that a better—"more compact"—product is obtained by *remelting* any alloy, may also have some connection with this custom.

‡ This explains the remark of Karsten (*loc. cit.*, S 386), that perfectly pure copper can take up from 1·5 to 2·5 per cent more zinc than impure, and still afford a product of better color, more tenacious and more malleable

§ Much zinc also is lost in this case, both by alloying with the foreign metal and by uniting with any oxygen which may have been combined with the latter. As the workmen say, impure copper "burns up" a great deal of zinc.

‖ It must be well understood, however, that as a rule manufacturers of alloys of copper and zinc always use the best copper they can obtain, since it is generally more economical for them to do so For the purer this metal is, so much the greater will be the total amount of alloy obtained by the use of a given weight of it, or, in other words, the loss, mentioned in the preceding notes, which would occur from elimination of impurities, will be smaller.

cannot be obtained if metals are present which are incapable of mixing in all proportions with this alloy, in which event small particles of the foreign substances would be found irregularly disseminated upon the fractured surface of the test ingot, manufacturers are enabled to ascertain at once whether or no a given sample of copper is suitable for the preparation of yellow-metal. Whenever it is found that satisfactory tests cannot be obtained, the copper is immediately rejected by the founders, and applied to some other use. No similar means of controlling the purity of the brass in question are known.

"It does not appear—at all events it has never been proved—that any serious injury results in practice from the use of the most varied kinds of copper, so long as they afford the desired *homogeneous* alloy containing 40 per cent of zinc.

"I do not wish to deny that hurtful impurities may at times occur in yellow-metal, in spite of the test to which I have so frequently alluded. Most probably the very rare cases in which this alloy wears out irregularly, portions of the sheet being much corroded, while other parts are scarcely at all acted upon and have preserved their original color and malleability, may be referred to the irregular diffusion of such impurities throughout the mass of alloy of which the sheet was formed;* but their influence must be regarded as being of very slight importance in comparison with the changes of structure which have already been discussed."

A detailed account of the method of analysis employed [humid assay by means of iron] and a list giving the composition of the different alloys examined, follows. As also, comments upon the violent action which is observed when zinc and copper enter into combination with each other, and upon the remarkable tendency to separate into layers, according to their relative specific gravity, without combining, which these metals exhibit when not mixed together by stirring.

"It is doubtless this tendency of the metals to remain unmixed in separate layers when not subjected to agitation, which has led several chemists to believe that the alloys of copper and zinc are apt to separate by eliquation into two portions respectively rich in copper and zinc; from which they have inferred, as I have previously remarked, the existence of definite compounds."

The color of the alloys is next considered.

"The most contradictory statements have been made by different observers in regard to variations of color among the alloys of copper and zinc. In the specimens which I have myself prepared, no abrupt change or peculiar modification of the true color is to be perceived, although some very striking superficial characters present themselves. Starting from the red of pure copper, the color of the alloys is less red and more yellow in proportion as they contain more zinc, until an alloy containing 75 or 80 per cent of copper is reached, the color of which is almost pure yellow; beyond this point, as the proportion of zinc contained in them is increased, the alloys become less yellow, with perhaps a tinge of green, and more white continually, and this by the most gradual stages, until the well-known white alloys are reached. These remarks refer to the color of polished surfaces as obtained by the use of a fine file."

In several of the alloys however, especially in those containing about equal parts of copper and zinc, a beautiful yellow or sometimes gray irid-

* It is not impossible that the small amount of silver which, as is well known, is precipitated from sea-water upon the metallic sheathing of ships, can accumulate to such an extent in yellow-metal which has been repeatedly used and remelted, that the durability of the latter may be seriously impaired thereby. It is, however, equally probable, and perhaps more so, that the greater part of this silver is eliminated in the preparation of the alloy, when the old metal is fused with zinc.

escent film forms upon the surface of the metal during the process of cooling. This is probably due to oxydation.

"Marked changes not only of color but also in other of the physical properties of some of these alloys may be produced by varying the conditions in which they pass from the liquid to the solid state. These changes are very peculiar and are evidently of great importance, not only in their practical bearing, but also from affording another instance of the phenomena of 'tempering' which may possibly be of consequence in the study of this most difficult subject."

"In preparing the white alloys containing less than 45 per cent of zinc, I have frequently observed, upon the under surface of the sheet obtained by pouring off the liquid alloy, a thin layer of a soft, tenacious, malleable alloy, of a yellow color. The formation of this singular sheet was at first attributed to eliquation; but as it was difficult to conceive that an alloy apparently richer in copper should remain at the surface of the melted mass in the crucible,—which must have been the case in order that it should form the bottom of the ingot,—it was thought possible that volatilization of the zinc might have increased the proportion of copper at the surface of the melted alloy. In order to decide this question, a new series of alloys was prepared, extending from the one obtained by melting together 40 parts of copper plus 60 parts of zinc, to the mixture of 56 parts of copper and 44 parts of zinc; —each alloy being made from a mixture containing one per cent more copper than that used in preparing the preceding. After thorough stirring, the alloys were cast into ingots of about five pounds' weight. In the first four of these alloys—from 40 to 44 per cent of copper—the yellow film was very clearly defined on the three sides of the ingot which had come in contact with the metal of the mould, while on the upper surface of the ingot, which had cooled in contact with the air, no trace of it could be detected. This yellow film is usually of extreme tenuity, hardly exceeding one-sixteenth of an inch in thickness in any of the instances which I have observed. It is, however, so very clearly defined in the white alloys containing 40 to 45 per cent of copper, being readily bent, cut, or filed, while the remainder of the alloy is exceedingly hard and brittle, that no question as to its identity can possibly be entertained. In the alloys containing more than 50 per cent of copper, which are naturally of a yellow color, it is not so easy to detect a similar film. In the series of ingots just mentioned, it could nevertheless be traced as far up as the alloy prepared from 54 parts of copper plus 46 parts of zinc.

"An experiment made in order to ascertain whether this soft modification of the alloys could be obtained at will, afforded no positive result. An alloy of 42 parts of copper plus 58 parts of zinc being prepared, a portion of it was poured by small drops into a large mass of cold water. The surfaces of many of the granules thus obtained were covered with a yellow film, and this was especially true of the smallest pieces; but the film was exceedingly thin, and the interior of the granules consisted entirely of brittle white alloy. Other portions were thrown out upon cold iron plates, so as to form very thin sheets. A thin yellow film occurred, it is true, upon the inferior surfaces of these sheets, but above it the alloy was white and brittle. Another portion of the melted alloy was cast in an iron ingot-mould which had previously been heated "black-hot." The yellow film was still formed where the alloy came in contact with the ingot-mould; it was, however, exceedingly thin. On pouring some of the remaining alloy into a cold iron mould, a yellow film of the usual thickness was obtained.

"Although the phenomena of tempering exhibited by these alloys are more readily perceived among those the normal color of which is white, it is highly probable that all the alloys are liable to have their physical properties influenced to a greater or less extent from this cause. This would appear, not only from the evident analogy of these phenomena with those which are known to occur with alloys of copper and tin;* but Dussaussoy† has already shown that ordinary brass, copper 65 to 70 per

* *Vid.* d'Arcet in *Dictionnaire de l'Industrie Manufacturière, etc.*, x, 500, Art. *Tam-tam* (Paris, Baillière, 1841); also, *Ann. Ch. et Phys.*, (2.) liv, 331. See also Dussaussoy, *Ann. Ch. et Phys.*, (2.) v, 225. † *Loc. cit.*, p. 226, *et Tableau* No. 5.

cent plus zinc 30 to 35 per cent, is rendered softer, less tenacious, and less dense by tempering it;—a fact which Mallet* has very properly urged in explanation of the differences between several of the specific gravities of alloys of copper and zinc observed by himself, and the numbers which had been previously obtained by other experimenters. I would here suggest that it explains equally well the very great variations among the specific gravities of the different alloys studied by Mallet himself.† It is also the most probable explanation of the alloys of abnormal color which he has described. I should observe in this connection, that in the alloys of light yellow color the yellow appears to be made much deeper when the alloy is strongly compressed, as when cut with a cold-chisel or hammered. I may also incidentally mention, that in the series of alloys which I have prepared, a constantly increased degree of hardness has been observed, in proportion to the amount of zinc contained in the alloy,—at least as far as the brittle white alloys, which are so hard that an ordinary file makes little or no impression upon them;‡ a result which agrees with those of Karsten,§ of Mallet,‖ and of Guettier.¶ Calvert and Johnson** have recently attempted to express these differences numerically. The alloy containing 54 per cent of copper, which is still so tenacious that small bits cannot readily be broken from it, was found to be exceedingly difficult to cut with a cold-chisel; for though still so soft that it could be filed without any very great trouble, it destroyed at once the edges of cutting instruments, though the latter were well tempered. This peculiarity appears to be connected with the fibrous structure of the alloy."

12. *Preparation of Oxygen on the Great Scale.*—In addition to the new methods of obtaining large quantities of oxygen which were reported on page 280, DEVILLE and DEBRAY have now published an elaborate article containing the details of their labors upon this subject to which we would call the attention of technological chemists. In this memoir, which forms a part of their remarkable monograph upon the metallurgy of platinum, &c., they have studied the comparative merits of all the industrial processes of manufacturing oxygen which were known heretofore and of the methods which they have themselves devised,—with a view of enabling any manufacturer to decide which process may be best suited to the locality or circumstances in which he happens to be situated. They describe also a method of preparing oxygen from chlorid of lime which seems to be well adapted for laboratory use,—when heated to low redness, chlorid of lime (bleaching powders) gives off, per pound, from twenty to twenty-five litres of oxygen. This gas is mixed with a little chlorine, from which it may be freed by washing with an alkaline solution, or better, the formation of this impurity may be prevented by adding enough slaked lime to the chlorid employed that this shall be strongly alkaline; if this precaution be attended to, the operation may be conducted in iron vessels. It is of importance only to avoid heating the mass to the fusion

* *Loc. cit.*, p. 264

† I have found it impossible to construct a curve of any regularity from the observations of this chemist, although it is tolerably clear that the greatest condensation is at a point somewhere below the alloy composed of equal equivalents of copper and zinc, and that between this point and pure copper the specific gravity gradually increases with some degree of regularity in proportion as the amount of copper increases Among the observed specific gravities of the white alloys rich in zinc, there is no regularity whatsoever. The determinations of Mallet are, nevertheless, unquestionably the best which have ever been made; possibly they are the best which could be made in any case. At all events, few chemists are in the position to improve upon the method of preparing alloys which was employed by this distinguished observer.

‡ From this category the alloys modified by tempering must of course be excepted.

§ *Loc cit.*, S. 393.

‖ *Loc cit.*, p. 307; also Gmelin's Handbook, (Cavendish Soc. Edit.,) v, 479.

¶ *Loc. cit., passim.* ** *Loc. cit.*, p. 199.

point of the chlorid of calcium. The calcination may even be made in glass vessels. The production of oxygen from this source is very regular and unattended with danger. The process is moreover economical as compared with those commonly employed by chemists;—in the experiments of the authors the cubic metre [35·316 cubic feet] of oxygen when prepared from black oxyd of manganese cost about four francs, from chlorid of lime five francs, while from chlorate of potash it could not be obtained for less than ten francs; but the process is nevertheless far more expensive than their sulphuric acid method, the cubic metre of oxygen having cost in this case not more than one or two francs,—and in practice the price would probably be much less than this, since the sulphurous acid might readily be utilized.

It is worthy of remark that the oxygen prepared from sulphuric acid can be easily obtained in a state of chemical purity.—that made from black oxyd of manganese is always contaminated with nitrogen.—*Ann. de Chim. et Phys.*, [3], lxi, 97, Jan., 1861.

13. *On the "Sweet Fermentation" of Milk.*—On the occasion of a discussion upon the conditions requisite for the preparation of butter, which took place at the meeting of the convention of Swedish Agriculturalists, in 1858, it occurred to Prof. ALEXANDER MÜLLER of Stockholm, that the simplest explanation of the multifarious appearances which must be noticed and the precautions to be followed in the preparation of good butter, was to be found in the supposition that the original albuminous envelopes of the fat globules in the milk must undergo a solvent fermentation before the butter can be collected. In proof of this view he now offers experimental results, of which the following table is an abstract: As Mitscherlich proved long ago, ether dissolves only mere traces of fat when shaken with milk as it comes from the cow, and dissolves so much the more fat in proportion to the length of time that the milk has been kept.

This milk, which for the sake of convenience had been diluted with an equal volume of water, gave up to ether in the *m*th hour after milking, in the *v*th hour after it had been diluted with water, and after it had been mixed with ether for one hour,* *f* per cent of fat.

No.	*m.*	*v.*	*f.*
1*a.*	2	1	0·55
b.	14	13	1·28
2*a.*	18	1	0·85
b.	38	21	1·52
c.	61	44	2·08
3*a.*	65	1	2·56
b.	86	1	4·52
c.	109	1	4·56

The temperature of the laboratory during these experiments was 15° C. [=59 F.]. No. 3*a*, curdled while being shaken with ether, 3*b*, and 3*c*, were already sour; the other samples were fresh and sweet when treated.

[* By long continued digestion with ether the author shows that much larger amounts of fat than those indicated in the table may be obtained. This has however no immediate bearing upon the point in hand. F. H. S.]

Although the specimens came from three different milkings, the results may nevertheless be regarded as a continuous series of determinations of the solubility of the fat in milk which had been kept from two to 109 hours. The solubility of the fat increased with the age of the milk, from 0·55 per cent in that kept for two hours, to 4·56 per cent in that kept during 109 hours, evidently in consequence of the destruction of the envelopes of the particles of butter, which had meanwhile been going on. It is probab!e that this solution of the coverings of the particles of butter is attended with oxydation, for the air of the vessels in which the milk was preserved contained less oxygen at the close than at the commencement of the experiment; from the experience of dairies it is also to be inferred that the solution of the envelopes of the particles of butter is retarded both by low and by high temperatures. Perhaps this solution is independent of the ordinary acid fermentation, but a more probable suggestion is that the envelopes of the fat globules may be the substance which excites the acid fermentation of the milk sugar, in one stage of which the caseine is coagulated.

The described solution,—or rather alteration, which the author proposes to designate as the "sweet fermentation (*Süsse Gährung*) of milk" must be of importance in explaining the rationale of the preparation of butter,—in which the chief object is to accumulate the fat particles without at the same time collecting any admixture of caseine.—*Journal für praktische Chemie*, lxxxii, 13, 1861, No. 1.

14. *Products from the combustion of Gunpowder under different pressures;* by B. F. Craig.—The perusal of the paper of Bunsen and Schiskoff on "The Chemical Theory of Gunpowder," whose publication about two years ago attracted much attention, (This Jour., [2], xxvi, 106), led me, as it no doubt did others, to make some experiments on the residues of exploded powder.

The investigations of the above-named chemists were made on the products of gunpowder which had been burned in small quantities, and under very slight pressure, and, in concluding their paper, they advance the supposition, that, under a difference of circumstances, the products may be essentially different from those which were obtained by themselves.

Such is actually the case, for the solution obtained by washing a gun with well boiled distilled water, immediately after its discharge, and filtering while hot, will be found to contain sulphuret of potassium with very small quantities of other substances, while Bunsen and Schishoff found their residues to consist mainly of sulphate and carbonate of potash. This difference is what was to be expected from our knowledge of chemical laws, and it is also to be observed that the products of combustion in the gun vary somewhat, according as the explosion takes place under a greater or less pressure. Thus in firing with a shot very heavy in proportion to the charge of powder, as in firing a mortar, the washings of the piece are found to be of a bright green color, while the ordinary washings of a gun are colorless after the suspended carbon has been allowed to sett!e, or has been removed by filtration.

The color above spoken of, is exactly the tint of a solution of a sesquisalt of chromium; it is not impaired by filtration of the liquid, but disappears in a few hours by exposure to the air, and immediately by the

action of acids. The cause of this color seemed to me at first obscure, but I found that by adding a very minute quantity of freshly precipitated sulphuret of iron to solution of protosulphuret of potassium, the same color was produced, and a sensible trace of iron may always be found in gunpowder.

A greenish color is frequently observed when sulphuret of iron is precipitated in the presence of an alkaline sulphuret, but as it disappears on standing, it has been commonly attributed to the presence of particles of sulphuret of iron held in suspension, an opinion which must be erroneous, since I have obtained a solution of iron in sulphuret of potassium of an intensely green color perfectly clear and transparent, and permanent for many days in a sealed tube.

Why this green compound should be formed under some circumstances, and not under others, in a mortar, and not in a cannon, is not insusceptible of explanation.

It has been shown that when powder is exploded under slight pressure the alkaline metal remains in large part as a sulphate, but under higher pressure and corresponding temperature, it is reduced to the condition of a sulphuret. Now, by analogy, it would seem, that with the ordinary charges of a cannon or musket the iron is not reduced to the state of sulphuret, but if, as is often the case in a mortar, the projectile is fifty times the weight of the powder, or upwards, the gases are brought to a state of great tension before the shot moves, and in that state of things the carbon is completely converted into carbonic acid, and the iron, as well as the potassium, brought to the condition of sulphuret.

Smithsonian Laboratory, Washington, D. C., Oct., 1860.

15. *On the Amounts of Lead contained in some Silver Coins;* by Eliot and Storer.—The determination of the amount of lead in American silver coin was suggested to the authors by finding half of one per cent of lead in a sample of zinc such as is used at the United States mint for reducing chlorid of silver. (See their Memoir on the Impurities of Commercial Zinc in Memoirs Amer. Acad., [n. s.], viii, 61; also this Journal, [2], xxxi, 142). For the sake of comparison other coins were subsequently examined.

Kind of coin.	Per cent of Lead in the coin.
1 American half-dollar of 1824,	0·310
20 " five-cent pieces of 1853,	0·209
10 " ten-cent " of 1854,	0·228
2 " twenty-five cent pieces of 1858,	0·231
"Fine Silver" from the U. S. Assay Office in N. York, 1860,	0·161
1 Spanish dollar of 1793, Carolus IV,	0·056
1 Mexican " " 1829,	0·043
2 English Shillings of 1816,	0·485
1 French five-franc piece of 1852, Napoleon III,	0·428

On the supposition that the zinc used in the reduction of the silver is the source of the lead in the American coin, the authors calculate the amount of lead which would thus find its way into the coin. Their memoir, already cited, gives the per cents of lead found in two specimens of Vieille Montagne zinc; if zinc of the best quality (containing 0·292 per

cent of lead) had been used, the silver coin would have contained 0·158 per cent of lead; if the second quality (containing 0·494 per cent of lead) had been employed, the coin would have contained 0·268 per cent of lead. Between these two limits all their determinations of lead in American silver coins lie. In offering this explanation of the occurrence of lead in American silver coin, the authors would by no means affirm that the zinc is the exclusive source of this impurity, for it is not at all improbable that a portion of the lead is derived from the leaden vats in which the reduction of the chlorid of silver is effected, or from the sulphuric acid which is used to excite the reaction. The process of analysis was such as to permit the separation of the gold contained in each kind of coin. A distinct button of metallic gold was obtained in every instance, before the blowpipe, but the amount of gold varied to a considerable extent; it was abundant in the American and Spanish coin, less was observed in the English and Mexican, and but little in the French coin or in the American fine silver. Brüel has remarked "that the process of separating lead and silver was less perfectly executed in the ages of antiquity than is at present the case." (*Karsten u. Dechen's Archiv. für Mineralogie, etc.*, 1844, xviii, 509), yet in none of the recorded analyses of ancient silver coins has any one detected so large an amount of lead as the authors have shown to occur in American fine silver of the year 1860, if a single analysis of Prof. Draper's be excepted which gave nearly three per cent of lead in a silver coin of Hadrian. It is probable however that the methods of analysis—none of which are recorded—employed for separating lead from silver by other chemists, were less delicate than those which the authors made use of and have fully described. The occurrence of lead in the American silver coin could probably be mainly, if not altogether, avoided, by employing zinc free from lead, such as is produced at the Zinc Works of Bethlehem, Pennsylvania. It is noteworthy that the American system of amalgamation, which has been so frequently criticised by European metallurgists, affords silver which is less strongly contaminated with lead, and is probably purer in other respects, than is produced by any other process of manufacture.—*Proceedings of the American Academy*, V, 52, Cambridge, Sept., 1860.

II. GEOLOGY.

1. *Botanical and Palæontological Report on the Geological State Survey of Arkansas;* by Leo Lesquereux.—This is a separate issue of the Botanical portion of the second Geological Report of Arkansas, just published, from p. 297 to 399, large 8vo, with five good plates representing new species of fossil plants from the Coal formation and one of fossil-leaves from the Tertiary. We regret that the separate title page is not dated. Considering that the operations recorded in this paper were made during a single, hasty, autumnal reconnaisance of the State of Arkansas, it is one of unusual interest and importance, and its plan may well be adopted for more thorough surveys under better auspices, especially as to what relates to the recent Botany, and general distribution of the plants of Arkansas. This part is introduced by the following appropriate—

"*General Remarks.*—The distribution of the plants of a country, according to the nature of its geological formations, is extremely difficult to settle with any chances of reliability. It has been asserted with apparent reason:

1st. That it is still uncertain if the chemical elements of the soil, even if it was proved that they are directly depending on the nature of the underlying geological strata, have a perceptible influence on the vegetation which naturally covers any peculiar place. That, in any case, the amount of influence which the chemical constitution of the soil exercises upon the distribution of the vegetation is still problematical.

2d. That the geological elements, viz., the particles resulting from the decomposition of the rocks and entering into the composition of the soil, even if their influence on the vegetation were well marked, are generally disseminated by water and atmospheric agency to a great distance from the areas occupied by the formations from which they come. The lime of a limestone ridge, the sand of a mountain of sandstone are carried down the declivities, spread over other kind of rocks, transported to the alluvial plains, or deposited on the banks of rivers and thus mixed together in a peculiar compound which, in its new state, has but an indirect relation to the rocks from which it is derived, and no relation whatever to the formations which it covers. Moreover, the frequent alternations of strata of sandstone and of limestone which compose the rocks of the great valley of the Mississippi, Silurian, Devonian, Carboniferous, and Tertiary, prevent an exact limitation of the area over which each of them may extend its influence. Thus, it has been generally admitted that physical circumstances more actively govern the distribution of the vegetation of a country than can chemical constituents of the rocks. Consequently, that the direction of the ridges, the amount of light and atmospheric heat and moisture, the thickness of the soil, its hardness and capacity for retaining water, are the essential causes of the distribution of the plants.

These considerations may be true, but they touch only one side of a complex and difficult question which cannot be discussed now. If the hardness, compactness of a soil, its capacity for retaining water and heat, are essential causes affecting the distribution of the plants, it is evident that this cause depends principally on the chemical nature of the geological strata. On the other hand, if the dissemination of the geological elements renders the task of ascertaining their influence difficult in some places, it is not a reason to reject as useless or impossible any attempt to compare the vegetation of a country with its geological formations. If this comparison can be made anywhere with a chance of success, it is certainly in Arkansas, where the strata are nearly horizontal and extend over vast areas.

The exploration of the Botany of Arkansas began too late and was too short to permit the fulfilling of a work which for its completion would require some years of continual research. The following data collected along our road of travel can thus be considered only as the first points of delineating lines which may be continued and completed hereafter."

Under the head of the Mammoth Spring of Fulton County, Mr. Lesquereux notices the rank development of aquatic vegetation which it supports, owing to the temperature of the water, constantly 60° Fahr., and the amount of air it is surcharged with. It would be well to know what proportion of this air is carbonic acid. The short section on the prairies of Arkansas is of such general interest that we cite the whole.

"*Prairies of Arkansas.*—Before entering into the examination of the botanical distribution characteristic of the part of Arkansas which I explored, there is still a peculiar question which cannot be easily treated elsewhere, and which calls at once for an examination.

The Prairies of Arkansas do not appear to have been formed all in the same manner. They are underlaid by different formations, situated at various elevations, and their general aspect differs apparently so much, that it looks as if a peculiar law had directed the formation of each of them.

I have explained elsewhere* the general formation of the prairies, and ascribed it to the agency of water. All the prairies still in a state of formation along the great lakes of the North are nothing else but marshes slowly passing to dry land by slow recession of water. When land is continually covered by low stagnant water, its only vegetation is that of the rushes and of the sedges. When the same land is alternately subjected to long inundations and then to dryness, during some months of the year, the same plants continue to cover it. By their decomposition these marshy plants produce a peculiar ground, either black, light, permeable when it is mixed with sand, as it is near the borders of the lakes, or hard, cold, impermeable when it is mixed with clay or muddy alluvium, as in some marshes underlaid by clay or shales, or along the banks of some rivers. Land continually covered with stagnant water cannot produce any trees, because the trees require for their growth, like most of the terrestrial plants, the introduction of atmospheric air to their roots. Neither do trees germinate and grow on a ground alternately covered with stagnant water and exposed to dryness for some months of the year. From these considerations, the law of the general formation of the prairies can be deduced: While a land or a part of a country is slowly passing from the state of swamp or marsh to the state of dry land the annual alternative of stagnant water and dryness causes the vegetation of peculiar plants, which, by their decomposition, form a peculiar soil unfavorable to the growth of the trees. From this general rule of formation, which regards only the prairies of the Mississippi valley,† all the different phenomena or peculiar appearances of the prairies can be easily explained.

The prairies of Arkansas, following their vegetation and their geological connection, may be separated into three classes:

1st. The prairies of the North, mostly underlaid by cherty limestone.

2d. The prairies of the West, on carboniferous shales and clay.

3d. The prairies of the South and East, overlaying tertiary and alluvial formations.

1st. The limestone prairies of North Arkansas mostly belong to the counties which are examined in the next division. They are singular in this fact, that their surface is not always flat, and that they are mostly placed on soft declivities or coves along or between the ridges. They are mostly of small extent and surrounded by thickets of low trees. The compact or somewhat porous Subcarboniferous Limestone which they cover does not absorb water with rapidity. Hence, in the spring, water percolates slowly along the slopes, taking with it the detritus of the stone, and depositing it where its course is either stopped or slackened. A scant swamp vegetation springs up there, its decomposed remains are mixed with the original deposit, which, by and by, augments in thickness under the action of water and of vegetation. This soil is naturally spongy, preserves water for a part of the year, like the peat, which it resembles, and thus cannot sustain trees. They establish themselves on a firmer ground all around. When by successive contribution of limestone deposited by water and of particles of humus received from the plants this soil has become thick enough, it is, when drained by a few ditches (serving as channels for the water of the rainy season), a fertile and easily cultivated ground. The channels of drainage are generally formed by a natural depression, the depth of which varies with the thickness of the soil of each prairie. In this case, as coarser materials are of course heaped on the banks of these creeks, a few

* Bulletin of the Society of Natural Sciences of Neuchatel (1856).

† The prairies of the far West, along the eastern base of the Rocky Mountains are true sandy deserts, caused by the dryness of the atmosphere.

trees grow along them. They are mostly stunted specimens of the Post-Oak, the Rock Chestnut Oak, the Persimmon, the Mockernut, the Juniper, and a shrub, *Bumelia lanuginosa*, Pers. The characteristic herbaceous plants of these limestone prairies are especially: *Ambrosia polystachya*, *Kuhnia Eupatorioides*, *Aster sericeus*, *Croton capitatum*, *Grindelia lanceolata*, *Palafoxia callosa*, *Oxibaphus albidus*, &c., species which are not found on the prairies of other formation. Besides these plants they are covered with a great number of species belonging to the prairies in general.

Between this and the second division of the prairies, viz., of those which are formed on the Carboniferous shales and clay, there is a remarkable transition, which unites both divisions, or rather shows their common origin. In the western parts of Benton and the northern part of Washington counties some flat prairies, formed like those of the second division, and underlaid by shales or red clay, have still at their surface some isolated patches of Subcarboniferous cherty limestone, which appear here and there, breaking the general horizontality like small mounds. Possibly these low mounds could support the vegetation of the trees, and they may have been transformed into prairies by the influence of fire, which is a secondary agent of their formation. But the soil which covers them is exactly of the same nature as the soil of the surrounding prairies, and as their height is no more than two or three feet, they may have been formed in the same manner and by the agency of water.

The prairies on the Carboniferous shales are generally flat, surrounded by hills, or at least by a higher border, which gives them the appearance of the bottom of drained lakes. These prairies are of various extent, and although they may overlie different kinds of ground or geological formation, in Arkansas they are generally underlaid by Carboniferous fire-clay or shales. In the spring they are covered with water which cannot percolate, and become true marshes for a time, and have the vegetation of marshes: the rushes and the sedges. This semi-aquatic vegetation gives, according to the nature of the underlying strata, either a hard, compact, cold soil, by decomposition of shales or clay; or, when mixed with sand, the peaty black soil of the prairies of Illinois and of the Northern States. In the summer months, these marshy prairies become dry by evaporation, and as it happens with the prairies of the first section, the alternative of too much water and of dryness in the soil prevents the growth of trees.

These prairies are more sterile or rather more difficult to cultivate than those of the former section, as we shall have occasion to see when examining the counties of Sebastian, Franklin, &c., where this kind of prairie is mostly found. A few trees,—the Water Oak, the Pin Oak, the Honey Locust,—grow along the creeks which meander in their middle. The soil is, in its natural state, mostly covered with the great Compositæ of the prairies and the hard grasses, species of Beard-grass and Broom-corn.

The prairies of the third class are extensively formed in Arkansas on the Tertiary or Alluvial land bordering some rivers of the South, especially Red River. Our exploration did not extend to that part of the State. It is very probable that these prairies have been formed in the same manner and by the same agency as those of the other sections. From the catalogue of Mr. Nuttall, who explored these plains, their plants appear somewhat different from those of the other prairies. They rather bear the character of a Western Flora, or of the Flora of the plains extending toward Mexico."

Then the geological nature of the soil, and the general characteristics of the vegetation, the agricultural capabilities, &c., of different districts of the State are considered in succession, and lastly, there is a catalogue of the plants of Arkansas, as far as known, systematically arranged, their Latin names, their English names, Geological station, and natural hab-

itat, being given in parallel columns, with well-chosen remarks upon properties and uses appended in foot notes.

The Palæontological part, noting that all the coal-beds of the State appear to belong to the lowest member of the Coal-formations, briefly mentions the characteristics of different beds examined, and describes 18 new species of plants from their overlying shales, and enumerates 50 others which have been elsewhere found. Leaves of a new supposed *Magnolia*, of a *Rhamnus*, and of a *Quercus*, are described and figured from a tertiary deposit. A. G.

2. *Prof. Heer's reply to Dr. Newberry on the Age of the Nebraska Leaves.*—The article of Dr. Newberry in this Journal, xxx, p. 273, having a few days ago come to my notice, calls for an answer from me, although it is with great unwillingness that I enter into controversy.

The point of dispute is known to be on the plants discovered in Nebraska. Dr. Newberry had remarked in relation to them (cf. *On the so-called Triassic rocks of Kansas and Nebraska by Meek and Hayden, this Journal*, [2], vol. xxvii, p. 33); 'the species of your fossil plants are probably all new, *though generally closely allied to the Cretaceous species of the old world*,' and, to prove this, he quotes the following genera: Sphenopteris, Abietites, Acer, Fagus, Populus, Cornus, Liriodendron, Pyrus?, Alnus, Salix, Magnolia, Credneria and Ettinghausenia. I took the liberty of remarking, that according to my views, the two last named genera were not correctly defined, and that the rest of the genera, quoted by Dr. Newberry are represented in the Tertiary and not in the Cretaceous. On this Dr. Newberry founded his charges, which, though answered already by Mr. Lesquereux, he repeats again. I allow myself to reply to them as follows:

1. In relation to the Credneria Dr. Newberry seems now to admit, that the leaves from Nebraska cannot be assigned to this genus, as he himself says: it may prove a new genus. In fact, all the characteristics of Credneria are wanting in these leaves, (to wit: those fine lateral veins, which stand out rectangular, proceeding from below the rigid secondary veins.) This very characteristic caused Mr. Stiehler to compare them with Coccolaba, whilst the leaves from Nebraska are very similar to those of *Populus leuce*, Rossm. sp. In this comparison I had not only examined the drawings of Rossmæssler and Unger, but also fine leaves of that species which were sent to me from Bognasco and Sieblos. The margin of these leaves is only sparingly dentate or even entirely toothless, and also only slightly wavy or undulate. I cannot agree to Dr. Newberry's Ettinghausenia any more than in regard to the Credneria. All the leaves of this genus, which are known to me, are serrate or dentate toward the apex, the leaf from Nebraska, on the contrary, has its blade divided into three lobes, and these have an even margin. This leaf seems to me rather to belong to Sassafras, of which genus Massalongo has one species presented in beautiful plates (in his *Studii della flori fossili del Senegagliense*). The same species (*S. Feretianum* Mass.) I have received from Merat, only the lobes in this are much shorter; of a second species (*S. germanica*, M.) I have a representation in my work on the flora of Skopau (cf. *Beiträge zur Flora des sachs. Braunkohlen*). A comparison of the drawings of the Nebraska leaf (in the Proceedings Acad. Nat. Sci. Phil-

adelphia, Dec. 1858, p. 223, Fig. 3,) with these Tertiary Sassafras species, and also with the Ettinghausenia, will satisfy every one that it is much more like the former and probably, therefore, is to be assigned to that genus. In relation to the separation of Ettinghausenia from Credneria, I did not intend to pronounce it in my letter to Mr. Lesquereux as unjustified. But Mr. Stichler certainly will willingly concede, that with the present materials it is impossible to establish this genus in a satisfactory manner; for Mr. Stichler himself has found cause to add the sign of interrogation to more than half of the species, mentioned by him among the Ettinghausenia. Dr. Newberry's assigning such a deviating form of leaf to this genus, proves the correctness of what I have said. Mr. Stichler has characterized excellently and circumscribed more strictly the genus Credneria, and separated from it a number of deviating leaves, which put us more in mind of Cissus, and has united them under one common name (as Mr. Bronn has done already before him). But at present it is impossible to characterize in a satisfactory manner this group of leaves, which itself seems to embrace very different elements. Wherefore it can justly be said, that this genus has no value whenever it is desired to fix the age of a certain formation, while, on the contrary, the several species of it may be of great importance in the decision. Therefore, I do not think that I have done injustice to Mr. Stichler by my having said so much in a letter to a friend, which letter was not intended for publication. That Dr. Newberry feels himself called on to appear as the defender of Mr. Stichler amuses me. The thought of offending Mr. Stichler never entered my mind, having lived for years in habits of friendly scientific intercourse with him, and holding his works in the highest esteem.

2. But if the Credneria and Ettinghausenia are now left out of the flora of Nebraska, and if the leaves so interpreted belong rather to the Tertiary than to the Cretaceous genera, the question may be put, on what grounds can the assertion of Dr. Newberry be established: that these plants ally themselves closely to the Cretaceous species of the Old World? As we remarked above, Dr. Newberry mentions besides Credneria and Ettinghausenia, eleven other genera, to the list of which he afterwards adds Platanus. These are all, however, well known Tertiary genera and several of them bear an important part in the Tertiary flora. Two of them (*Sphenopteris* and *Abietites*) are not of any importance in this discussion, being present in nearly all the formations and therefore not peculiar to any one of them; but this is not the case with the rest of them. Dr. Newberry now maintains, that several of these are contained in the work of Stichler (*über die Kreideflora des Hayes Palæontographica*, v, 23), and puts the alternative that either I have not known the work of Stichler, and am, therefore, not competent to give an opinion upon it; or I have known it, and a severer expression would be justified. To this I have to reply, that Mr. Stichler, in the work mentioned, describes only the genera: Credneria, Ettinghausenia, Weichselia, Pandanus, Pterophyllum, Delesserites, and mentions *Salicites? fragiliformis*, etc., and *Juglans Humboldtiana;* but in the introduction, (p. 50), he mentions, that Mr. Apothecary Hampe gives the following additional genera: Chondrites, Halymenites, Equisetum, Pecapteni, Flabellaria, Pinites, Geinitzia, Arau-

carites ? Comptonites, Salicites, Populus, Alnites, Acer ? and Quercites. Mr. Stichler, however, says, (p. 50), *that most of these vegetable remains need further examination, which was not possible, until more perfect specimens were on hand, and he enumerates expressly certain insufficiently determined genera :* viz. Comptonites, Salicites, Populus and Alnites. Mr. Stichler, therefore, does not enter into those at all, although his work treats on the very flora of this locality, and this evidently only for want of material for a description in any way adequate. These are precisely the genera to which Dr. Newberry refers, and for which he reproaches me, as either not having taken notice of, or else of willingly ignoring them. I confess freely, that in my opinion it is not possible to build such important conclusions on such uncertain data, and that it were better to lay them aside until a somewhat more correct solution is possible. But if, for argument's sake, we should accept these definitions of Mr. Hampe, based upon incomplete materials and pronounced unsatisfactory by Mr. Stichler himself, Dr. Newberry's position is not thereby bettered, as that list contains only two of the genera mentioned by him, Populus and Acer, and this last one, Stichler himself designates immediately afterwards as Acerites ? That Acerites is not the same as Acer, Alnites not Alnus, and Salicites not Salix, it is surely not necessary to argue any further at present. They designate only similar forms of leaves, which, however, are so incompletely preserved, that a stricter definition could not be formed, as Mr. Stichler himself shows, that Salicites fragiliformis is not a proper Salix, but is better to be designated as Phyllites. It is true, Messrs. Gœppert, Reuss and Dunker mention saliciform leaves in the Cretaceous formation, but in none of all the now known species are the veins sufficiently preserved to enable us to recognize in them the characteristics of the Salix: the definitions, therefore, have to remain yet unsettled.*

Mr. Ettinghausen is of the same opinion; (cf. *über die Proteaceen der Vorwelt, S.* 3), according to him *Salicites angustus* Reuss belongs to *Grevillea, Comptonites antiquus* Nils., however, to *Dryandra.* Thus stands the matter in relation to those genera, which, according to Dr. Newberry, Nebraska has in common with the Cretaceous formation. Six of Dr. Newberry's genera, however, (Fagus, Cornus, Liriodendron, Pyrus, Magnolia and Platanus), are not mentioned at all, either by Mr. Stichler, or in any work on the Cretaceous flora. Therefore, I do not feel that I deserve the reproaches of Dr. Newberry, while at the same time I consider myself justified in declaring again, on the present occasion, that the very genera mentioned by Dr. Newberry himself argue in favor of the Tertiary flora and not of the Cretaceous, and that, consequently, his assertion, that the Flora of Nebraska is closely allied with the Cretaceous of Europe, is not supported by the evidence. It is entirely incomprehensible to me,

* The *Salicites Hartigi* Dunk., cannot belong to Salix: not only are the shortened lateral veins different, but also the terminations of the secondary veins. In Salix they form arches, not reaching the margin, while in these Salicites (at least in the drawing), they reach the margin. *Salicites Potzeldianus* Gœp., (Nov. Act. Acad. Lœp. xix, t. 47; fig. 18), Mr. Gœppert himself considers as very dubious. In this species occur also those shortened lateral veins characteristic of the willows. *Carpinites arenaceus* Gp., (l. c. Taf. 47, fig. 19, 20) cannot be compared with Carpinus; the secondary veins terminate in arches.

how he can say "the fossil flora of Blankenburg is indeed strikingly like that of our lower Cretaceous strata," (this Journal, [2], xxix, p. 211),—a flora so wholly different from the present European and American, while living representatives still occur in America of nearly all of the now known genera of the flora of Nebraska.

3. If the relations of the strata and the fossil remains of animals make it indubitable that the fossiliferous sandstone in Nebraska and Kansas belongs to the Cretaceous formation, it follows of course, that these plants have to be assigned to the Cretaceous flora. In this case the interesting fact would present itself, that the Cretaceous flora of America differs entirely from that of Europe, and is more closely related to that of the middle Tertiary. The Coal flora of America corresponds in many of its most important types with that of Europe, as shown by the excellent works of Mr. Lesquereux, likewise the flora of the Keuper, as we learn from the distinguished labors on these plants by E. Emmons; further, the Miocene flora of Vancouver shows the most striking relationship with the Miocene flora of Europe; the Cretaceous flora, therefore, would form a remarkable exception. We must, of course, not forget, that the Cretaceous flora of Europe has not been as yet extensively examined, and that many new forms will doubtless yet come to light. The Tertiary flora shows such an abundance of Dicotyledons, that in all probability many more of its typical genera than are known at present have their original forms in the Cretaceous epoch, among them, perhaps, some of those which came to our knowledge from Kansas and Nebraska. It is, however, worthy of notice, that the Eocene flora of Europe, (i. e., that of Monte Bolca, of the Isle of Wight, of St. Zacharie in Provence, and of Skopau), does not contain those genera mentioned by Dr. Newberry (with the exception of Acer), and that they do not make their appearance in Europe before the lower Miocene epoch, while, on the other hand, they are entirely missing in Aix, the richest spot for Cretaceous plants known, although the sands and clays of Aix belong to the upper Cretaceous formation (*Turonienne*); wherefore we must suppose here a nearer approach to the Tertiary flora, than in the lowest Cretaceous, to which the formation of Nebraska is said to belong. The materials before us enable us to assert, that the Cretaceous flora of Europe has an entirely different character from that of Nebraska, and I will try to prove this more satisfactorily.

We have in the Cretaceous flora of Europe, numerous and mostly peculiar Filices, differing in type from the present European forms. We notice among them beautiful Gleicheniaceæ, (one genuine Gleichenia), and large Danæaceæ, among which the superb Weichselia reminds us of Anomopteris of the varigated sandstone, and which, with several more extinct genera, (Moriconia, Benizia, Bonaventura, Manheimia, etc.), gives the Cretaceous forms a peculiar feature. Among Monocotyledons we meet Palms, Pandaneæ and Scitameneæ, (Cannophyllites); among the Gymnospermæ also a considerable number which remind us of the Cycadeæ of the Jurassic flora, (Cycadites, Pterophyllum, Pterozamites, Microzamia and Zamiostrobus), and numerous peculiar Coniferæ, of which the genus Cycadopsis, (*Geonitzia*), related to Sequoia, has spread very largely. With this, and with those forms which are closely allied to the Indio-Australian

Damaræ, Cunninghamiæ and Arancariæ, are mixed (according to epistolatory communications from Dr. Debeg), several most peculiar extinct genera; the Dicotyledons, which, as is well known, appear first in the Cretaceous formation, present themselves in the lower chalk only in few, (namely in Credneria and Ettinghausenia), but in the chalk of Aix, in numerous species. According to the communications from Dr. Debeg, to whom we owe an excellent work on these plants, (cf. *die urweltlichen Thallophyten und Acrobryen, Denkschriften der Wiener-Academie*, xvi, and xvii), he has discovered in Aix about 200 species of Dicotyledons. Among them are prominent the Proteaceæ, (60–70 species), Grevillea, Hakea, Banksia, Persoonia, and some other Dryandreæ, appearing among them; but also the Myrtaceæ, are pretty numerously presented, (Eugeniæ, Eucalypti, and Leucospermum), whereas the Leguminosæ are entirely wanting. Among the Amentaceæ appear the genera Ficus and Quercus, and of the Juglandeæ Gœppert has already made known the fruit of a walnut-tree. But those leaves also described by Dunken as Cytisus [Cretaceous] belong in my opinion to Juglans and Carya.* This flora of Aix shows, therefore, a decided Indio-Australian character, and approaches thereby the Eocene flora, while that of the older Chalk formation is foreshadowing the transition to that of the Jura. How different the flora of Nebraska appears, having all the now known genera in common with the Miocene flora, and all the dicotyledoneous generic types met in America at the present time! If it really belongs to the oldest Chalk formation, the flora of that epoch would closely ally itself to the present flora of America, and there had (judging by the small amount of materials) since that time not occurred any new arrangement which had materially changed the genera, while this was the case in Europe in a high degree. Many peculiar forms join the older Jurassian types in the lower Chalk, and the Dicotyledons appear mostly in now extinct genera; after this the flora assumes more and more the Indio-Australian character, which continues through the Pliocene flora to the commencement of the Miocene; then the Indio-Australian types retreat by degrees into the background, making room for the American, this prevailing to the end of the Miocene epoch, and, in single species, reaching into the Pliocene, while in the Quaternary epoch the Asiatic types make their appearance, with the present creation, predetermining the character of the vegetation. No doubt it is possible, that the American flora has assumed from the Cretaceous period an entirely different development from that of Europe; but ere we accept such a remarkable phenomenon as a fact, we had rather wait for further examinations of the localities where the Nebraska leaves are found. I must confess that I cannot suppress my doubts about the correctness of the classification of them, and I appeal to the experience we have had in Europe. How easily accessible are our Alps in comparison to the parts of America in question, and how long a time did it take, before we were correctly informed on the relations of the strata of the most important formations; and how much are we in the dark yet about some parts of those very mountains! It is now generally admitted, that with us older formations are resting on Tertiary for an extent of over 36 miles. "There

* They cannot belong to Cytisus, because the secondary veins project too much; they have, however, the character of walnut-leaves.

exists," says Studer, (*Geologie der Schweiz*, ii, f. 4), "in this mountain group of several square leagues, the wonderful arrangement, that Flysch and Nummulite-sandstones, which we have learnt to recognize as the last sediment-formation in the system of the Alps, here appear in the foundation of the Verrunaco, of the Jura and of the Chalk-formation, not otherwise as we are used to see gneiss and mica-slate in other parts of the Alps or in the palæozoic formations in other mountain systems." If Dr. Newberry could visit the Glärnisch, (Canton Glarus), on the eastern slopes of which true Jurassic to a great extent lies over nummulitic chalk in a nearly horizontal position, he, perhaps, also would find, that, without the shadow of a doubt, one must believe the Nummulitic-chalk older than the Jura.

I cannot close this note without expressing my deep regret for having been obliged thus publicly to defend myself against Dr. Newberry. There are so few men engaged in the study of fossil plants, and the field is so immensely extensive, that it would be better to devote our time to this work, and not to useless disputes. I have, however, not sought this discussion, and only entered into it compulsorily; and I hope that in future I may meet Dr. Newberry, who has already rendered to science such important services, on more pleasant grounds. OSWALD HEER.

Zurich, Dec. 15, 1860.

3. *On the causes which gave rise to the generally elongated form and parallel arrangement of the pebbles in the Newport Conglomerate;* by Prof. WILLIAM B. ROGERS (from Proc. Boston Sci. Nat. History).—Referring to the characters of the conglomerate as presented at Purgatory and other places in the vicinity of Newport and indeed generally throughout its outcrops, Prof. Rogers commented on the hypothesis by which it had lately been proposed to explain the elongated form and parallel arrangement of the pebbles in the massive strata of the rock. He described the steep and alternating dips of these thick beds of conglomerate at and near Purgatory, as made apparent by the occasional layers of interposed sandstone, and pointed out the general parallelism there and elsewhere of the flat sides of the pebbles to the planes of deposition as well as the prevailing uniformity of direction of their larger axes.

He urged that such an arrangement of the pebbles corresponds precisely with the effects of *wave and current action* on water-worn and partially water-borne fragments during their accumulation. The large proportion of pebbles of elongated shape met with in these beds was, he considered, the natural consequence of the mode of disintegration of the original metamorphic rocks from which the pebbles were derived. Such rocks, in virtue of sharply intersecting joints and cleavage planes are prone in many localities to break up in long irregular somewhat rhombic figures which by the wearing action of streams and tides are easily converted into oblong pebbles like those of the Newport conglomerate. Examples of this mode of disintegration are common in the more altered belts of the Appalachian region, especially among the silicious and argillaceous slates along the southeastern border, and may be seen at various points among the similar altered rocks of New England.

To the hypothesis of Prof. Hitchcock (see Prof. H.'s paper in this No.) that these elongated pebbles owe their peculiar shape and position to the

action of powerful pressure upon the strata while the pebbles were in a soft condition from intense heat or other causes, Prof. Rogers urged the following objections:

1st. The effect of pressure upon a plastic solid, as shown by Sorby and Tyndal, is in all cases to develope more and more distinct cleavage planes throughout the mass, these planes being uniformly at right angles to the direction of the pressing force. Such an action applied on a large scale to the strata of conglomerate must therefore have had the effect not only of flattening the plastic pebbles in a uniform direction, but of developing a cleavage or lamination in them all, parallel to their flat sections as they lie in the mass. But this is so far from being the fact that we find the cleavage planes of different pebbles running in wholly different directions, sometimes across, sometimes parallel, and sometimes oblique to the general bedding, just as might be expected from the preservation of the original cleavage-structure of the rock from which they were derived.

2d. Such a moulding of the pebbles by pressure would either enormously distort or entirely obliterate any fossil forms or impressions which may have existed upon or within the pebbles at the time of their deposite. But an inspection of the Lingulæ from the Taunton River conglomerate and of a similar fossil found subsequently by Mr. Easton in the conglomerate of Newport shows that no such violence could possibly have operated on the mass.

3d. While in the localities referred to the *majority* of the pebbles have the oblong shape and parallel arrangement above described, there are many scattered through the mass, which are either nearly round or have their longer dimensions more or less transverse or even perpendicular to the general direction. As these could not have escaped the enormous, all-pervading, softening action and pressure which the hypothesis assumes, their presence in these discordant conditions seems of itself a sufficient refutation of the theory.

In regard to the curved form and close adaptation observed in some of the pebbles, Prof. Rogers thought that accidental peculiarities of shape in the original fragment and the effects of attrition and the close packing of the accumulated deposit furnished an adequate explanation both of the bent form sometimes met with and the accurate fitting of the contiguous pebble to the concave surface.

As an example of the formation of flattened pebbles by the action of the shore waves, Prof. Rogers referred to the paving stones of slaty trap recently imported from Newfoundland, which are remarkable for their very uniform circular outline, their smooth, slightly convex faces and a thickness rarely exceeding one-third of their breadth. If we suppose a great mass of these, as they lie piled along the shore with their broad sides horizontal, to be hereafter cemented together as a stratum of conglomerate rock, would not the argument founded on their shape and position be even stronger than in the case of the Newport conglomerate? Yet nothing is more certain than that they owe their shape and arrangement to the peculiar movement and attrition to which they have been subjected by the action of the waves.

Thus as regards the Newport rocks and most other conglomerates which had fallen under his notice, Prof. Rogers saw no difficulty in refer-

ring the form and arrangement of the pebbles to the familiar agencies indicated. He does not however doubt that in some highly metamorphic districts, conglomerate rocks are to be found which have sustained great internal changes through the effects of heat, chemical action and violent pressure. Such he has long thought must have been the conditions in some parts of the Blue Ridge and South Mountain chain in the Middle States, and such perhaps were the influences which operated on the Gneissoid conglomerates of the Green mountains, to which Prof. Hitchcock has referred in his recent communication to the Society.

MINERALOGY.—

4. *Note on Chloritoid from Canada;* by T. STERRY HUNT, F.R.S.—Among the crystalline Palæozoic schists of the Notre Dame Mts., which are the Canadian prolongation of the Green Mts., of Vermont, is a rock characterized by the presence of a mineral which has been designated in the Reports of the Survey by the name of phyllite, from the supposition of its identity with a similar mineral from Massachusetts, described, named and analyzed by Thompson. The mineral in question is abundant in a fine grained grayish wrinkled micaceous schist from Brome and in larger specimens from Leeds; where it occurs in a similar rock which is pearl gray in color, passing into greenish gray, and contains a large proportion of quartz with a mineral talcose in aspect, but aluminous in composition, and apparently micaceous. Similar micaceous schists containing the mineral in question may be traced in the continuation of the Notre Dame Mts., as far as Gaspé. In the rock of Leeds the phyllite occurs in small lamellar masses rarely more than one-fourth of an inch broad and one-eighth of an inch thick. In some specimens it forms spherical aggregations half an inch or more in diameter composed of radiating lamellæ and sometimes making up one-half the volume of the rock. In most localities however the masses are smaller and less abundant. The mineral has a perfect cleavage in one direction and two less distinct transverse cleavages, 'the lamellæ are often curved and are not easily separable. Hardness 6·0, density 3·513, color dark greenish-gray to black; brilliant black on the surfaces of perfect cleavage which have a vitreous lustre; the cross-fracture is granular and exhibits a feeble waxy lustre. The streak and powder are greenish gray. The mineral resembles somewhat a dark colored variety of hypersthene.' The analysis of a carefully selected specimen from Leeds gave as follows:*

Silica,	26·30
Alumina,	37·10
Protoxyd of iron,	25·92
Protoxyd of manganese,	·93
Magnesia,	3·66
Water,	6·10
	100·01

This analysis shows the mineral to be chloritoid, with which its specific gravity and other characters agree. It is the *barytophyllite* of Breithaupt, the *masonite* of Jackson and the *sismondine* of Delesse. All of these minerals occur in argillaceous, micaceous or chloritic slates and

* Report of Geol. Survey of Canada, 1858, p. 194.

having a hardness of 5·0—6·0, and a density of 3·45—3·57, have been united with chloritoid, with which they agree in composition. (Dana, *Mineralogy*, ii, 298).

The phyllite of Thompson according to the analysis of that chemist contains a larger amount of silica than chloritoid together with more manganese, and 6·80 p. c. of potash, but having had occasion to repeat several analyses of this chemist, I have found that his determinations of alkalies are entirely erroneous. Thus in the case of raphyllite a tremolite containing only traces of alkalies he indicated more than ten per cent of potash and in his retinalite, a pure serpentine, nearly nineteen per cent of soda.* In both cases the error was at the expense of the magnesia of the mineral. The substance examined by Thompson has not so far as I know been examined or identified by American mineralogists, but in the minerological cabinet of the Laval University at Quebec, is a specimen from the collection of the late Mr. Heuland; said to be phyllite from Massachusetts, which is evidently chloritoid, and cannot be distinguished from the specimens of that mineral just described; the rock is also apparently identical.

The ottrelite of Haüy, to which Dana has referred the phyllite of Thompson, occurs in an argillaceous slate in Belgium, and in a specimen before me cannot be distinguished from the phyllite from Massachusetts or the chloritoid of Canada. This mineral has however been analyzed by Damour, whose name is a guarantee for accuracy, and differs from chloritoid in containing a considerable excess of silica, which might possibly be derived from the gangue. The specific gravity which Damour has assigned to ottrelite is 4·4—which is so extraordinary for a mineral of that composition that we are led to suspect some error probably of the press or pen. The question of the identity of ottrelite with chloritoid is one which requires farther examination. Meanwhile the latter mineral assumes some importance to the lithologist as characterizing over wide areas considerable masses of schists, which we have elsewhere described as chloritoid slate.

III. BOTANY.

1. *Journal of the Proceedings of the Linnæan Society; Botany.* No. 18 (1860), contains, (1.) Notes on *Ternstrœmiaceæ*, by George Bentham, V.P.L.S. A critical survey of the order (for which we could have wished that the name *Camelliaceæ* were adopted), in which Mr. Bentham retains the *Sauraujeæ*, and to this refers *Stachyurus*, very properly reducing *Draytonia* to *Sauravja;* also the *Gordinieæ* or proper *Camelliaceæ*, and the *Bonnetieæ*, to which he joins the genus *Marila;* and finally he makes of the *Marcgraviaceæ* another tribe of the same order. The known species of *Cairapa* are described in a note, with several other new plants of Spruce's collection.

(2.) Mr. Crocker, a foreman in Kew Gardens describes the curious germination of *Streptocarpus polyanthus* and a few other *Cyrtandreæ* of similar peculiarities. In the adult state, the plant above mentioned has only one leaf,—a radical one—and this, as Mr. Crocker shows, is one of the cotyledons, which from a microscopical size expands in germination

* Report of Geol. Survey of Canada, 1850, p. 40.

and at length becomes about a foot long, the flowerstalks springing from its sinus. The two cotyledons grow equally for the first few days, but one of them is soon arrested while the other grows on in this remarkable manner. *S. Rexii* and *S. biflorus* show this remarkable peculiarity, but also develope a plumule of two or three smaller leaves.

(3.) The Notes on *Anonaceæ*, by George Bentham, indicate the principles adopted in the forthcoming revision of this order for the new *Genera Plantarum*, and characterizes several new species. The rather numerous instances in which the petals are imbricated in æstivation, as in *Magnoliaceæ*, are mentioned, and the æstivation is (perhaps rather too much) used in the division into tribes.

(4.) *Botanical Memoranda*, by George Bentham. In this short paper Mr. Bentham discusses several topics with his well-known ability and good sense. We must demur to his conclusion that the so-called involucre of *Anemone* answers to a single amplexical divided leaf, and would refer to the involucels of two opposite leaves in *A. Virginiana* and *A. Pennsylvanica* in proof of the contrary; nor can we regard the change from alternate to opposite or verticillate leaves as so anomalous or so unusual as in itself to give likelihood to the new hypothesis. The more elaborate ensuing note on the stigmas of *Papavaraceæ* is clear and admirable.

(5.) On *Fissicalyx*, a new genus of *Dalbergieæ* (No. 2223 of Fendler's Venezuelan collection), by the same author.

(6.) Account of the plants collected by Dr. Walker in Greenland and Arctic America during the expedition of Sir Francis M'Clintock in the Yacht 'Fox,' by Dr. J. D. Hooker.

(7.) *Hepaticæ India Orientalis*, by Mr. Mitten; commenced.

Supplement to vol. v.; *Botany*, 1860, contains the *Florida Adenensis*, by Dr. Thomas Anderson, a botanist of excellent promise; 43 pages, with 6 plates. Ninety-four species compose the known phænogamous flora of this arid little peninsula of Aden, belonging to 79 genera and 41 natural orders. Most of these species are scarce in individuals, only a few of the more arid forms predominating; all are more or less peculiar in their habit, and destitute of a bright green color; nearly all are glaucous, whitened, or hoary, many are fleshy, and 16 bear sharp thorns. "All the species have to strive against conditions tending to the entire extinction of vegetable life;" and "the flora appears to be a collection of desert species, selected from widely different natural orders and genera, and all alike contending with the excessive heat and drought." "In so dry a climate, Ferns and other Cryptogamia except Lichenes, are quite unknown." A. G.

REVIEW.—

2. *Life on the Earth, its Origin and Succession;* by JOHN PHILLIPS, M.A., LL.D., F.R.S., late President of the Geological Society of London, Professor of Geology in the University of Oxford. Cambridge and London, Macmillan & Co., 1860, pp. 224, 12mo.—A book with this taking title, especially in these days, is sure of a prompt and wide circulation,—all the more so when the author is an Oxford Professor, and a Rede Lecturer at the sister University. The subject and the author here command attention and respect, and excite a high degree of expectation. We imagine that those readers who take this volume for what it really is, viz.,

as amplification of "the Rede Lecture," delivered in the year 1860, before the University of Cambridge, and as a popular exposition, by an able geologist, of an interesting scientific topic—will not be disappointed.

On the other hand, those who take it,—as the title-page might lead them to do—either for an original speculation upon the Origin and Succession of Life on the Earth, or for a serious and sustained criticism of the particular hypothesis which Mr. Darwin has recently propounded, will hardly have their expectations satisfied. Yet, along with a large amount of very good elementary exposition, some considerations are adduced, and some points are made, which are extremely noteworthy, and which show how well Professor Phillips could have discussed the whole subject, at least in its geological bearings, if he had seriously undertaken it.

The best point, as it strikes us, which Professor Phillips makes against Darwin is drawn from a comparison of fresh-water with marine Mollusca, —the latter of numerous and widely diversified types, and of great change on the whole from age to age; the former of comparatively few types, and much alike all over the world and throughout geological time as far back as they can be traced.

"If, in either of these cases, the Unionidæ, the Paludinadæ, the Limnæadæ, Planorbes, Physæ, &c., the modern forms are derived from the ancient, we have the full measure of the whole variation,—the differentials of change are all integrated by time, and we behold the sum —how little! But if not so, if the modern and ancient species have sprung from different branches of a stem still older than either, how much stronger, if possible, is this decisive testimony against the doctrine of indefinite change through time and circumstance! Circumstances have varied, ages have passed away, and yet every generic group exhibits at every step the same essential characters, and many of the little peculiarities, such as eroded beaks, plications on the surface, reflexions of the lip, carinations of the whorls, which cannot be consistent with accumulated tendencies to change, (p. 113). "The discovery of a land-shell allied to if not identical with Pupa, in the interior of a fossil tree (Sigillaria) in the coal-formation of Nova Scotia," (p. 116), is an analogous case.

To enforce the argument we need the statement,—which we wonder Prof. Phillips has not adduced, and which we suppose may be safely ventured upon,—that fluviatile and terrestrial conditions must all along have been more variant and diverse, and therefore more favorable to the eduction and natural selection of variations according to the hypothesis, than marine. Yet while, under the comparatively uniform conditions of the latter, every thing 'doth suffer a sea-change into something rich and strange," the freshwater and terrestrial genera remain almost unaltered. Put in this form, the objection appears to us a formidable one, which we should not know how to answer. Yet, on the whole, there is, as there should be on the theory, a far greater diversity on land than in salt water. The common form of similar objections misapprehends the theory, by assuming that actual variability is something constant and equable—a uniform and measurable force acting always and upon entire species—so that so much time should bring to pass so much change; or else, that the external conditions really produce the variation;—while, also, that *com-*

plex which is condensed and rather boldly personified by the term Natural Selection is no better comprehended by many naturalists than is the Malthusian theory by many political economists.

In view of the fact that a large number of existing species appear (by the evidence of their remains) to have existed from near the beginning of the pleistocene or quaternary epoch, and that the difference between the fauna of that period and the present consists merely in the extinction of a number of species, Mr. Pictet convincingly argues that the actual geological epoch, the present creation, began at the close of the tertiary. Professor Phillips would seem to go farther; for, in view of the similar, though less universal identifications by which "the tertiary series is linked in easy harmony with the actual period," he concludes that; "The present age is in fact a part of the great cænozoic period," (p. 169, 170), under which term, as the preface informs us, he "comprehends not only the eocene, miocene, and pleiocene of Lyell, but the whole series of supra cretaceous deposits." Looking then at "examples of parallel forms of Mammalia now living with some of the tertiary quadrupeds once denizens of the same regions, or regions formerly connected by land," or where, "without this close affinity, a considerable resemblance is found between special tribes now living and others fossil in the same region," as in a part of America "among the Edentata, which though not quite confined to that region, are more plentiful there than elsewhere, and are successors of fossil races also found almost exclusively in that country;" noting also that the marsupial mammals of Australia had marsupial predecessors, our author continues:—

"The peculiarity indeed is of far earlier origin; for it occurs in the eocene deposits of the basin of Paris, in the lacustrine deposits over the upper oolite at Stonesfield, and probably in the Trias of Wurtemberg. In respect of the Stonesfield fossils, this is not the only evidence presented by that curious deposit of similarity of mezozoic life in the north and cænozoic life in the antipodal region of the south. It extends to other groups, both of the land and sea, and almost justifies the notion of some affinity even in the systems of life. For just as at Stonesfield, so in Australia, small insectivorous marsupial mammals are associated with Cycadaceous plants and Ferns; as now in the seas surrounding Australia, Terebratula and Rhynchonella, Trigonia and Cucullæa, consort with Turtles and the Cestraciont Sharks, near reefs of coral, and rivers tenanted by Gavialian Crocodiles, so at Stonesfield in the older time, similar animals in similar combination.

"What does this teach us? Are we looking upon two partially similar, but really separate creations suited to partially similar conditions in very different periods of time? Or is the life-system of the modern Australian land and sea truly derived in some of its components by descent with modification from the older periods of the world, and preserved to this our day, notwithstanding displacement over half the circumference of the globe, and all the vicissitudes of an immensity of time?" (p. 171, 172).

The author proceeds to answer these questions in the following passages in which his volume culminates:

"Whoever has the courage to adopt the latter view must accept with it the obvious inference, that, in all the countless ages which have rolled away since the branches [?] of Zamia were blown into the lagoon at Stonesfield, the amount of organic change has been small in each group of plants and animals; that a similar amount of change affected the unlike inhabitants of land and sea; that Mollusca and Sharks, and Turtles and Crocodiles, have all been modified by differences of a small description in passing from Oolitic to modern times, while not only hosts of Ammonites and Belemnites have perished in the experiment, but many new forms, as Oliva, Mitra, Triton, Struthiolaria, unknown in the earlier period, have come into view in the latter. But let it be adopted. What follows? These small differences then, accomplished in all that prodigious range of elapsed time, under all that variety of physical changes and removals; these are all the mutations which have been possible under the constant tendency of hereditary descent to perpetuate similar forms with modification.

"One of these genera, that of Trigonia, is known to be in the fossil state rich in species. Supposing them all to have come from one original typical form, the differences which they show in strata of the same system, deposited within the same grand period, and under much similarity of conditions, argue a facility in giving variations: let this operation be supposed to be continued in the interval between the epoch of Stonesfield and that of Australia, and the effects summed by natural selection, the result is the modern *Trigonia*, scarcely differing more in appearance from the fossil species than they differ one from another. But, if not so derived by continual descent, but sprung from separate contemporaneous branches of one stem of life, how should it happen that plants and quadrupeds on land and mollusks in the sea, should in each of these two cases pass with equal advance along the streams of change, moving in one case so fast, in the other so slow? But if the branches sprang at different times and led to these similar results, would this double origin in time, for several similar forms in similar associations, fit with the hypothesis of continual development?"

This is neatly put. But it seems to be founded on the supposition that variation in descent is somehow *caused* by time and change, and goes on by something like equal increments in equal times; whereas, the cause of variation is wholly occult,—the fact is, that some forms remain long invariable or slightly variable under the same conditions in which others vary freely. If Mr. Darwin's theory is bound to explain variation, or to assign a reason for one species varying when another does not, then it utterly fails, for it can do no such thing. If, however, it does not undertake to account for the diversity of species except by regarding them as varieties of earlier origin and wider divergence,—leaving the reason why the progeny is sometimes unlike the parent in one or more particulars as much unexplained as why it is usually like it, but showing how the struggle for life ensures the extinction of crowds of intermediate forms, and now the resulting natural selection may lead certain surviving races farther along the lines of favorable variation,—then it avoids the force of many of the criticisms which have been directed against it.

The criticisms from which, however, it is least able to escape are those which call for lacking intermediate forms between tribes, families, and other great groups, or for some evidence that they ever existed. Here Prof. Phillips as a geologist feels his advantage and urges his point more aptly than some other critics have done.

"The explanation offered in the hypothesis of Mr. Darwin is, that the groups of life which appear to be and really are distinct, in the Cambro-Silurian rocks are not aboriginal forms, but derived from progenitors of far earlier date, belonging to few types or to one, the original form, and the transition forms being known to us. Now they are not unknown to us by any impossibility of being preserved, for the strata of the Cambro-Silurian series are of a kind in which organic remains of great delicacy are often preserved, and indeed such are preserved in these very strata; and by the hypothesis the life-structures which are lost must have only gradually differed in their nature from those which are preserved. It follows, therefore, that the earlier-living progenitors of the Cambro-Silurian series not only lived long before, but must have lived somewhere else. But as in all the known examples of this series of strata, wherever found, we have everywhere animals of the same general type, and nowhere the traces of the earlier progenitors, it is clear that everywhere we are required by the hypothesis to look somewhere else;—which may fairly be interpreted to signify that the hypothesis everywhere fails in the first and most important step. How is it conceivable that the second stage should be everywhere preserved, but the first nowhere?" (p. 214, 215.)

So, also, of what follows:

"Are we sure that varieties which are given by nature in successive generations can be *summed up in one direction* by the variable preponderant of a number of *concomitant variable conditions* of life? Can we remove 'natural selection' from the large synonomy of 'chance' except by giving to one of the variable conditions of which it is the sum, direction, definite value, or effect. Is it not the one acknowledged possession of every species, an inherent tendency to propagate its like? Would not the effect of this one constant among any number of variables without law be to preserve the characters of the species forever?" But what, we ask, is this inherent tendency of the species to propagate its like but the summing up in one direction of the tendency of each generation of individuals to propagate its like? Is not the occasional appearance of an offspring unlike the progenitor as much a natural fact as the contrary? And does not each initial variety, once originated, also have an inherent tendency to propagate its particular like, which, when it prevails for some generations, fixes a new "constant" which would equally tend "to preserve the characters of the 'variety' forever?"

"And," continues our author, "if 'natural selection' were regarded as giving direction to these variables, in combination with that constant tendency, what would be the final result but that which has always been recognized, viz: a species varying within limits which are to be sought out by experience. But finally, if natural selection be thus gifted with the power of continually acting for the good of its subject, encouraging it, or rather compelling it to continual advancement,—how is this beneficient personification to be separated from an ever-watchful providence,—

which once brought into view sheds a new light over the whole picture of causes and effects?" (p. 215, 216).

We answer, nohow, except by indicating to some extent the mode or way in which this Providence may operate.

The more we can recognize or clearly conceive the mode, the better; but, whether we can express the results of observation in the form of general laws or not, we are equally convinced that "what would be regarded as remarkable inventions if they were due to human minds and hands," "cannot be removed from the list of intelligent adaptations because they are frequent in nature, and are of higher perfection and greater beauty than any work of man;" and that "no one will ever be [or rather, reasonably can be] satisfied with laws which had no Author, works which had no Maker, co-ordinations which had no Designer."

And our author does simple justice to Lamarck in giving him the benefit of his own averment that "by Nature we are to understand a certain order of causes and effects constituted by the will of the Supreme Author of all things." The points against Darwin's theory made or suggested in the present volume, with so much acuteness, are all the more telling for the entire fairness and excellent spirit in which they are made. This is far more than can be said of the following essay, viz:

3. *Species not Transmutable nor the Result of Secondary Causes; being a Critical Examination of Mr. Darwin's Work*, &c; by C. R. Bree, Esq., M.D., F.L.S., &c.—London, Groombridge & Sons.—A favorable notice in the Athenæum of Dr. Bree's volume led us to suppose that it might be a contribution of some importance in the discussion of the nice questions which the publication of Mr. Darwin's book has raised. But this expectation has not been fulfilled on perusal. The author's intentions are praiseworthy, and his zeal in a good cause exuberant. But we cannot entertain a great respect for the reasoning of a writer who, on the one hand sees design and adaptation in the distribution of sunshine and rain, and the succession of the seasons, while on the other he insists that *because* "all the parts of a creature act harmoniously and co-ordinately one with another," necessitating the inference "that they were preordained to act collectively for the animal," therefore "they could not have been produced by [through] variation, natural selection, divergence of form," or indeed through any secondary causes whatever. We are unable exactly to comprehend how one who sees design and adaptation realized in the inorganic world through what are called secondary causes, is entitled to declare that the establishment of the doctrine of the succession of species,—each marked with more special if not stronger evidences of design than anything in inorganic nature,—through secondary causes, would "destroy every vestige of a shadow of belief in a watchful Providence and adaptive creation, and strike deeply and irrecoverably at the root both of natural and revealed religion." In our opinion such defenders of the faith play unwittingly into the hands of its most dangerous adversaries. A. G.

IV. BOOK NOTICES.

1. *The Manufacture of Vinegar: its Theory and Practice, with especial Reference to the Quick Process;* by CHARLES M. WETHERILL, Ph.D., M.D. Philadelphia, Lindsay and Blakiston, 1860. 12mo, pp. 300.—This is a very full, correct, and much needed treatise on an important branch of technology, and the book does credit both to the author and to the publishers. It is well printed and contains but few typographical errors, among which we remark "Bertholet" for "Berthelot," on p. 17, and "Reaumer" in all cases for "Reaumur."

The author professes to have based his work on Otto's "Lehrbuch der Essig Fabrikation," and says in the preface, "The general division of the work, many of the tables, all of the wood cuts, except two, and the quantitative analysis of vinegar, are borrowed from Otto." The first division of the book is devoted to an explanation of the general principles of chemistry, with especial reference to the subject in hand,—to an account of the nature, properties and transformations, of sugar and alcohol, and to a discussion of the various methods of determining the strength of alcoholic liquors and vinegars. The second part gives the practical details of the vinegar manufacture. Scientific accuracy is maintained throughout, and to the trained chemist the book is valuable as giving in one volume all the important matters relating to these various subjects. But though the general principles are clearly stated, it seems doubtful whether a mere practical man could fully comprehend all that is laid down. Yet he could understand enough to prevent him from becoming the dupe of men who make a great secret of the vinegar business and pretend to an exclusive knowledge of valuable receipts or methods. At the present time when scientific schools in various parts of our country, bring instruction within the reach of all who desire it, no one should engage as manager in the manufacture of vinegar, or in any other chemical manufacture, without previous study of chemistry and some training in chemical manipulation. One may learn a great deal from books, if he first learns how to understand books. One may derive much benefit from experienced workmen, if he first acquires a knowledge of natural laws and principles so that he can exercise a just control over the whims and prejudices which such workmen always possess. Like men of other trades, the vinegar maker too often insists on trifling points for which no better reason can be rendered than that such has been his beaten track; to such the work now under consideration will prove very useful, as it gives many actual variations in the practical details, thus showing that there are more ways than one of arriving at the same end.

One or two incidental matters occur in the book, to which we must be allowed to take exception. Wood vinegar is spoken of as "pyroxilic acid," and *pyroxylic*,—which is of pure Greek origin,—perhaps it ought to have been called; but the mongrel word *pyroligneous* has been so long exclusively in use that it should pass as the established name. The author also substitutes the term "raisin sugar" for *glucose*, because "*glucose* means *sweet*, and raisin sugar is inferior in sweetness to either

cane or fruit sugar." It would have been well to consider that *glucose* is derived from the positive γλυκύς, and not from the superlative γλύκιστος; and nobody ever thought of calling metamorphosed starch *glucistose*, as the sweetest thing known. The transformations of starch, by the way, recall an undue extension given on p. 66,—and indeed very commonly in books,—to the name "British gum." Practical men—or at least many of them—distinguish roasted wheat starch as *British gum*, while roasted potato starch is called *gum substitute*. And the distinction is said to be founded on a real difference as great as that between the starches themselves.

In speaking of the expression "proof spirits" the author says, "the vinegar maker should be entirely ignorant of proof." But as long as spirits are bought and sold according to 'proof,' neither the buyer nor the seller should be ignorant of what the term means. The common material used in this country for making vinegar by the quick process, is whiskey. The consumer buys it at a specified price for the quantity of *proof spirit* that it contains. He buys say 1000 gallons of rectified whiskey at 25 cts. per gallon, and how much must he pay for it? It is invoiced perhaps as "40 over proof," that is, the 1000 gallons are actually equal to 1400 gallons of *proof spirit;* so the bill amounts to $350. To see whether this charge is correct he should test the liquor by the alcoömeter. One per cent of "dry" (absolute) alcohol is equal to two per cent of proof spirit—that is, New York proof. Hence if the article examined stands at 70° Tralles, it contains 140 per cent of proof spirit, or in commercial language is 40 over proof. So the vinegar maker can no more afford to be "ignorant of proof" than he can ignore the meaning of the term *gallon*.

The subject of acetometry is pretty fully discussed, and by the methods given, one accustomed to nice chemical manipulation will find no difficulty in determining the strength of vinegar. But it is desirable that the common workman should have some simple mode for testing the generators from day to day to see that they turn out a uniform product. There is such a plan in use among calico printers,—a plan which dispenses with exact weighings and measurings and nicely adjusted alcaline liquids, and is therefore deserving of especial mention in any work intended for practical men. Dry slacked lime is added to some of the vinegar to be tested, until there is an excess of lime present, which is known by a sudden change in the color of the solution to yellow or brown and the precipitation of some flocculent matter. The resulting liquid is allowed to settle and is at the same time cooled to 60° F. The hydrometer strength of the clear solution is now noted, and by reference to a table constructed for the particular hydrometer used, the strength in acetic acid will be found with accuracy, enough for all common purposes. Of course this method is applicable only to pure vinegars made from diluted alcohol. Whiskey vinegar is now very largely consumed in calico printing, and for this use it is commonly required to contain five per cent of dry acetic acid. The acetate of lime made from a vinegar of this strength stands at 8° of Twaddle's hydrometer.

The second part of the work describes several different arrangements of the apparatus for making vinegar as well as various modes of working; and one about to start or remodel a manufactory, would derive much advantage from a careful study of the many plans here detailed. Yet some questions might be asked to which the book gives no satisfactory answer. The first point to be decided is, of what size shall the graduators be made? They commonly have an average diameter of about 3½ feet and a height not exceeding 12 feet. But they seem to be so made rather from precedent than from any actual necessity. It is quite likely that there would be some advantage in having them much wider. As for height, we have no published accounts of any generators higher than 13 feet; and of course the greater the height, the greater is the difficulty of maintaining a sufficient circulation of air through the filling of shavings. Private experience however has shown that twice the ordinary height is none too great. For there are in this country generators in successful operation having a full height of 22 feet. The liquor to be acetified is raised, once for all, and passed through the 20 feet of filling, drawn out at bottom as finished vinegar. These long graduators produce quite as much strong vinegar for the same amount of filling as those of half the height worked in pairs; and being furnished with the feeding apparatus to be described presently, they dispense with a large part of the labor and attention required in the older ways of working.

As to the form of the generators, a word may be said. They are made somewhat conical so that the hoops may be driven tight; but which end should be uppermost? Graduators are always described and depicted as standing on the smaller end. Yet we cannot think of a single advantage in having them so set. It is true the filling usually shrinks more or less in the course of time, and one might suppose that were the taper from the bottom upwards, the filling would draw away from the sides and leave there too free a passage for the air. But it is a somewhat yielding mass we have to deal with. Therefore while it is shortened vertically it presses out laterally. There are on the other hand some slight reasons for departing from the usual custom and adopting the more stable position. The liquor to be acetified is likely to be more uniformly distributed in its passage downwards, if it is showered on the smaller end of a right conical column than when it falls on the larger base of an inverted frustrum. Again the liability to lateral leakage would be much lessened. In the third place some of the hoops require to be renewed while the generators are in operation, and it is easy enough at any time to slip a hoop over a smaller top and drive it down, but to get one up from below is by no means easy. It is particularly difficult to replace the bottom hoop when this has the least diameter of all.

There is much difference of opinion and practice with reference to the admission of air. Some "practical" men insist on boring the holes three or four feet above the false bottom. Others make them an inch or two above. Some lay great stress on bringing in the air by one or more wooden tubes passing up through the bottom of the generator and terminating just below the false bottom on which the filling rests. They forget that air is an elastic fluid and tends to diffuse itself equally

in every direction so that if it only has a chance to enter anyhow or anywhere below the filling, there is no danger of a partial distribution. There can be no simpler or better plan than to bore two or three holes in the sides just below the sieve bottom. If they are above, there is a chance for the filling to press against the inner orifices and hinder the ingress of air; and to go very high up, is to lose the benefit of all the filling below the holes.

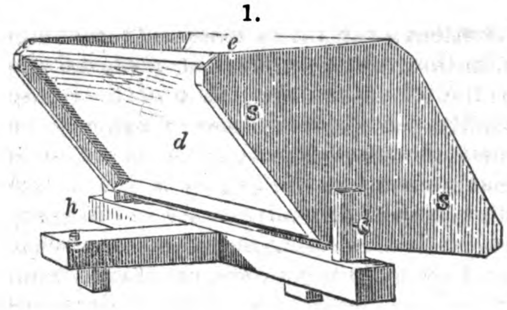
While speaking of air it may not be amiss to mention a very natural mathematical oversight that occurs in Dr. Wetherill's book on p. 259. It is said that:—"Otto discovered by numerous experiments that the air leaving generators in good action, contained from 14 to 16 per cent of oxygen, equivalent to from 4·9 to 6·9 per cent of the oxygen of the air employed in the vinegar fermentation." As in atmospheric air there is 20·9 oxygen to 79·1 nitrogen, an atmosphere that contains 16 per cent of oxygen or 84 per cent of nitrogen, must have had originally with this 84 of nitrogen $\frac{20{\cdot}9}{79{\cdot}1} \times 84 = 22{\cdot}2$ of oxygen. Hence it has lost $\frac{22{\cdot}2 - 16}{84 + 22{\cdot}2}$ $= 5{\cdot}84$ per cent of the air itself or 27·8 p. c. of its oxygen. And so when an air contains 14 p. c. of oxygen, it has lost 8 p. c. of its first weight or 38·4 p. c. of its oxygen.

It is said that some manufacturers allow the vinegar to flow out at bottom as fasts as it trickles down, yet we nowhere find a sufficient reason rendered for this plan. Our author after describing a goose neck arrangement, as well as a peculiar cock for drawing the vinegar always from the very bottom of what is constantly accumulating, goes on to say:—"Besides the advantage of saving heat, the vinegar drawn from the bottom of the tub, as by the action of the goose neck or faucet, is of stronger quality, for several reasons which will be given in the proper place." This "proper place," however, is not to be found in the book, and a statement so very questionable is left unsupported by any reasoning. If there are any real advantages in the goose neck or any similar contrivance, it is desirable that they should be specified; for one who has never used such arrangements, can hardly conceive how anything can be, on the whole, better than periodical drawings from a common cock.

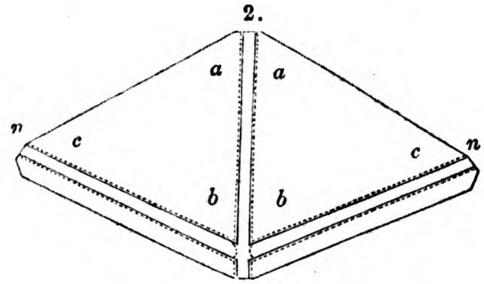
The filling is commonly looked upon as merely presenting an extended surface over which the liquor to be acetified flows in a tortuous course from top to bottom. But perhaps the graduator ought rather to be considered as a kind of apparatus for "displacement." It is not improbable that the alcoholic mixtures instead of simply trickling over the shavings saturated with vinegar, partly drives this absorbed vinegar before it, and so a part of the fresh mixture may be several days in reaching the bottom. In fact if we fill a generator with shavings soaked in water and then run on strong vinegar at a moderate rate, we find that it is some time before anything but water flows out from the bottom. This idea of displacement, if correct, ought to be taken into account in theorizing about the process, and it has also some practical bearings. Among other things it should enter into the discussion of the comparative advantages of a constant and a periodical running of the alcoholic mixture. In the case of an interrupted flow, the pores of the filling

have a chance each time to empty themselves partially of liquid and become filled with air; and the air will thus be brought into more intimate contact with the liquor of the next pouring. While with a constant flow, the air will be present only in the interstices and not in the pores. Our author very justly considers that pouring at intervals would be preferable to the constant flow, if it could be effected without the great amount of care and manual labor which it commonly requires. He probably is not aware that there has been used in some manufactorics in this country, a very simple automatic pouring arrangement which leaves hardly anything to be desired. The principle is that of the oscillator in Gay Lussac's sulphuric acid apparatus. A barrel supported above the graduator, is furnished with a wooden cock which delivers the alcoholic mixture in a very slender stream into a vessel so poised that it shall tip and discharge its contents whenever it has received as much liquor as suffices to cover completely, for a moment, the distributing sieve head. The apparatus used by some consists of a single vessel which rights itself as soon as it has poured out its charge. But as this is made partly of sheet copper, it is liable to obvious objections. The writer has had in operation for more than a year, double oscillators made entirely of wood dove-tailed together. They are easy to construct and very satisfactory in their performance. Each of the compartments holds a wine gallon, which is amply sufficient to cover a sieve head 30 inches in diameter. Fig. 1 is a perspective view of the oscillator mounted on its frame. Fig. 2 shows the inside of the end piece with the dove-tail grooves, *n*, *n*. The whole of the oscillator itself is made of pine boards five-eighths of an inch thick. In the triangles *a b c*, the side *a c* is $7\frac{1}{2}$ inches long, *a b* is 6 inches and *b c* is 7 inches. The sides of the box *d* are $13\frac{1}{2}$ inches long, not including the dove-tail tongues. The middle piece *e* has a shallow, round, or angular groove on each side to receive the lower edges of the side pieces *d*. These side pieces are held fast by the pins *S*, *S*. An indentation on the outside of each end piece receives the sharp point of a brass or iron screw *G*, and on these points the box turns. The right place of the axis is determined by actual trials of the box temporarily poised at diffe ent points along the shorter diagonals of the end pieces. After the oscillator is permanently mounted, the tipping may be still farther adjusted by varying the height of the cushions *h* on which the sides *d* drop. The whole apparatus should be well painted before it is set on a sieve head. J. M. O.

1.



2.



2. *Chambers' Encyclopædia: a Dictionary of Universal Knowledge for the people.* Illustrated with maps and numerous engravings. Large 8vo. Vols. I and II. J. B. Lippincott & Co., Philadelphia. W. & R. Chambers, Edinburgh. 1860.—This excellent Encyclopedia is on the basis of the German *Conversations Lexicon.* It is to be completed in six or seven volumes of about 800 pages each, and fully illustrated with woodcuts in the text and colored maps on steel. Its scientific articles are varied and generally able, covering natural history, physics, astronomy, topography, geography and medicine. The maps are models of clearness and elegance in that style of illustration, which they understand so well in Edinburgh. Messrs. Chambers have earned a well deserved reputation for their efforts to open the treasuries of human knowledge to the people, and in this new enterprize we see the culmination of all former efforts. It will, by the terms of its prospectus, be the cheapest general encyclopedia ever published, as well as one of the most comprehensive. It contains, as is just, few lengthy treatises such as we seek in the Encyclopedia Brittanica and in the American Cyclopedia, thus conforming more strictly to the original idea of an encyclopedia, which was first realized in English by Ephraim Chambers in his Universal Dictionary of Knowledge (1728), the basis after the 6th edition, (in 1750) of Dr. Ree's Cyclopedia. We cordially commend the new Chambers' Encyclopedia as worthy of a place in every collection of books for reference.

3. *New American Cyclopedia.* Appletons, N. Y. 1861.—This able and useful work has reached its 11th volume, ending with the word 'Moxa.' It is the plan to close it with the 16th volume. Among the noticeable scientific articles in the 11th volume are '*Microscope*' and '*Mineralogy*,' the first due, as we infer, to Dr. Reuben, and the last to Mr. Hodge, both authors of numerous scientific articles of merit in this Cyclopedia. It is to be regretted that a work in general so excellent should not include in its plan of publication those simple illustrations without which it is hardly possible to make intelligible certain subjects, especially in physics and natural history. During the hours devoted to looking through these volumes, lingering with satisfaction to read not a few of their instructive articles, we have been much impressed with the great amount of discriminating labor and knowledge involved in the management of so great a variety of subjects.

4. *Second Report of a Geological Reconnoissance of the Middle and Southern Counties of Arkansas, made during the years* 1859 *and* 1860, by D. D. Owen, Principal Geologist, assisted by Robert Peter, Chemical Assistant, Leo Lesquereux, Botanist, and Edward Cox, Assistant Geologist. Philadelphia: C. Sherman & Son, Printers. 1860. 8vo, pp. 433.—Having already devoted p. 431–435 to an extended notice of the botanical portion of this Report, we can only add here its title in full. It is beautifully printed, and will be regarded with interest as the last labor of the lamented Owen. The Chemical Report by Dr. Peter contains the results of the analyses of one hundred and eighty-seven soils, subsoils, and underclays, and two nitre earths, besides a variety of other chemical work. The volume is concluded by a brief report by Assistant Cox.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Catalogue of the Meteoric Collection of* CHARLES UPHAM SHEPARD, deposited in the Cabinet of Amherst College, Mass.

METEORIC STONES.

1. 1492, Nov. 7, *Ensisheim*, Alsace, Dép. du Haut-Rhin, France.
2. 1753, July 3, *Tabor* (Plan, Strkow), Bohemia.
3. 1753, Sept. 7, *Liponas*, Dép. de L'Ain, France.
4. 1768, Sept. 13, *Lucé* en Maine, Dép. de la Sarthe, France.
5. 1768, Nov. 20, *Mauerkirchen*, Inn, Lower Austria.
6. 1790, July 24, *Barbotan*, (Roquefort, Créon, Juillac, Mezin, Agen, &c.), Dép. des Landes, Dép. du Gers, Dép. du Lot et Garonne, formerly Gascony, France.
7. 1794, June 16, *Siena*, Tuscany.
8. 1795, Dec. 13, *Wold Cottage*, Yorkshire, England.
9. 1798, March 8–12, *Salès* near Villefranche, Dép. du Rhône, France.
10. 1798, Dec. 13, *Benares* (Krakhut village), Bengal, E. Indies.
11. 1803, April 26, *L'Aigle*, Normandy, Dép. de l'Orne, France.
12. 1803, Oct. 8, *Apt* (Saurette), Dép. de Vaucluse, France.
13. 1805, March 25, *Doroninsk*, Government Irkutsk, Siberia.
14. 1806, March 15, *Alais*, St. Étienne de Solm and Valence, Dép. du Gard, France.
15. 1807, March 13, *Timochin*, Juchnow, Smolensk, Russia.
16. 1807, Dec. 14, *Weston*, Connecticut, U. S. A.
17. 1808, April 19, *Parma* (Casignano, Borgo St. Domino), Italy.
18. 1808, May 22, *Stannern*, Iglau, Moravia.
19. 1808, Sept. 3, *Lissa*, Bunzlau, Bohemia.
20. 1810, Aug. *Tipperary* (Mooresfort), Ireland.
21. 1810, Nov. 22, *Charsonville* near Orleans, Dép. du Loiret, France.
22. 1811, March 12, *Kuleschowka*, Gov. Poltawa, Russia.
23. 1811, July 8, *Berlanguillás*, near Burgos, Upper Castilia, Spain.
24. 1812, April 15, *Erxleben*, between Madgeburg and Helmstaedt, Prussia.
25. 1812, Aug. 5, *Chantonnay*, between Nantes and La Rochelle, Dép. de la Vendée, France.
26. 1813, Sept. 10, *Limerick* (Adare, Scagh, Brasky, Faha), Limerick county, Ireland.
27. 1814, Feb. 3, *Bachmut* (Gov. Iekaterinoslaw), Russia.
28. 1814, Sept. 5, *Agen*, Dép. du Lot and Garonne, France.
29. 1815, Oct. 3, *Chassigny*, near Langres, Dép. de la Haute-Marne, France.
30. 1818, April 10, *Zaborzika* (Saboryzy, Saboritz on the Slutsch,) Volhynia, Russia.
31. 1818, June, *Seres*, Macedonia, Turkey.
32. 1818, Aug. 10, *Slobodka*, Iuchnow, Gov. Smolensk, Russia.
33. 1819, June 13, *Jonzac* (Barbezieux), Dép. de la Charente, France.
34. 1819, Oct. 13, *Politz*, near Gera, Dutchy of Reuss.
35. 1820, July 12, *Lixna* (Liksen), Lasdany, Gov. Witepsk, Russia.
36. 1821, June 15, *Juvenas*, near Libornez, Dép. de l'Ardèche, France.

37. 1822, Nov. 30, *Futtehpore*, near Allahabad, Hindostan, E. Indies.
38. 1823, Aug. 7, *Nobleborough*, Maine, U. S. A.
39. 1824, Jan. 15, *Renazzo*, Ferrara, Papal States.
40. 1824, Oct. 14, *Zebrak* (Praskoles), near Horzowitz, Beraun, Bohemia.
41. 1825, Government *Iekaterinoslaw*, Russia.
42. 1825, Feb. 10, *Nanjemoy*, Maryland, U. S. A.
43. 1825, Sept. 14, *Honolulu* (Owyhee, Hawaii), Sandwich Islands.
44. 1826 or 1827, *Waterloo*, New York, U. S. A.
45. 1827, May 9, *Nashville*, Tennessee, U. S. A.
46. 1827, Oct. 5, *Bialystok* (Knasta, or Kuasti village), Russian Poland.
47. 1828, June 4, *Richmond*, Virginia, U. S. A.
48. 1829, May 8, *Forsyth*, Georgia, U. S. A.
49. 1829, Aug. 15, *Deal*, near Long Branch, New Jersey, U. S. A.
50. 1831, Sept. 9, *Wessely* (Dorf Znorow), Moravia.
51. 1833, Nov. 25, *Blansko*, Bruenn, Moravia.
52. 1834, June 12, *Charwallas*, near Hissar, E. Indies.
53. 1836, Nov. 11, *Macao*, Prov. Rio Grande de Norte, Brazil.
54. 1837, Aug. *Esnaude*, Dép. de la Charente, France.
55. 1838, June 6, *Chandakapore*, Berar, E. Indies.
56. 1838, Oct. 13, *Capeland* (Cold Bokkewelde), Cape of Good Hope, Africa.
57. 1839, Feb. 13, *Little Piney*, Pulaski County, Missouri, U. S. A.
58. 1840, July 17, *Cereseto*, near Offiglia, Casale, Piedmont.
59. 1840, *Concord*, New Hampshire, U. S. A.
60. 1841, March 22, *Grüneberg* (Heinrichsau), Prussian Silesia.
61. 1841, June 12, *Château-Renard*, Dép. du Loiret, France.
62. 1842, April 26, *Milena* (Milyan), Pusinsko Selo, Croatia.
63. 1842, June 4, *Aumières*, Canton St. George, France.
64. 1843, March 25, *Bishopsville*, South Carolina, U. S. A.
65. 1843, June 2, *Utrecht*, Blaauw Kapel, Loewenhutye, Netherlands.
66. 1843, Sept. 16, *Klein-Wenden*, near Nordhausen, Prussia.
67. 1844, April 29, *Killeter*, County of Tyrone, Ireland.
68. 1844, Oct. 21, *Favars*, Canton de Laissac, France.
69. 1846 or 1847, *Richland* (near Columbia), So. Carolina, U. S. A.
70. 1846, May 8, *Macerata*, Monte Milan village, Ancona, Papal States.
71. 1847, Feb. 25, *Linn county*, Iowa, U. S. A.
72. 1848, May 20, *Castine*, Maine, U. S. A.
73. 1849, Oct. 31, *Cabarras county*, North Carolina, U. S. A.
74. 1850, Nov. 30, *Shalka* (Sulker, near Bissempur), Bancoora, India.
75. 1851, April 17, *Guetersloh*, Westphalia.
76. 1852, Sept, 4, *Mezö-Maduras* (and Fekete), Transylvania.
77. 1853, March 6, *Segowlee* (Soojoulee), India.
78. 1853, Feb. 10, *Girgenti*, Sicily.
79. 1854, Found. *Pegu.*
80. 1855, May 13, *Bremervoerde*, Landdrostei-Stade, Hanover.
81. 1855, Aug. 5, *Petersburg*, Lincoln county, Tennessee, U. S. A.

82.	1857, Oct. 10,	*Ohaba*, East of Karlsburg, Transylvania.
83.	1857, Feb. 27,	*Parnallee*, S. Hindostan.
84.	1858, May 19,	*Kakova*, Northwest of Oravitza, Temesvar, Banat.
85.	1858, Dec. 9,	*Ausson*, (Montrejean), France.
86.	1859, March 26,	*Harrison county*, Kentucky, U. S. A.
87.	1859, Aug. 11,	*Bethlehem*, near Albany, New York, U. S. A.
88.	1860, May 1,	*New Concord*, Muskingum county, Ohio, U. S. A.

METEORIC IRONS.

Dates of Discovery or of Fall.			
1.	Fell	1751, May 26,	*Agram* (Hraschina village), Croatia.
2.	Discov.	1751,	*Steinbach*, between Eibenstock and Joharn-Georgenstadt, Saxony.
3.	"	1768,	*Senegal*, Siratik in Bambuk, Africa.
4.	"	1776,	*Krasnojarsk*, Gov. Jeneseisk, Siberia.
5.	"	1784,	*Toluca*, (Xiquipilco), Mexico.
6.	"	1788,	*Tecuman* (Otumpa), Argentine Republic, S. America.
7.	"	1792,	*Zacatecas*, Mexico.
8.	"	1801.	*Cape of Good Hope*, Africa.
9.	"	1811,	*Elbogen*, Bohemia.
10.	"	1811,	*Durango*, Mexico.
11.	"	1814,	*Bitburg*, Lower Rhine, Prussia.
12.	"	1814,	*Texas* (Red River), U. S. A.
13.	"	1815,	*Lenarto*, Scharosch, Hungary.
14.	"	1816,	*Bahia* (Bemdego), Brazil.
15.	"	1818,	*Lockport*, New York, U. S. A.
16.	"	1819,	*Burlington*, Otsego County, New York, U. S. A.
17.	"	1820,	*Guildford*, North Carolina, U. S. A.
18.	"	1824,	*Rasgata*, New Grenada, S. America.
19.	"	1827,	*Atacama*, Bolivia.
20.	"	1828,	*Caille* (Grasse), Dép Du Var, France.
21.	"	1829,	*Bohumilitz* Prachin, Bohemia.
22.	"	1834,	*Claiborne County*, Alabama, U. S. A.
23.	Fell	1835, July 30,	*Dickson* county, Tennessee, U. S. A.
24.	Discov.	1835,	*Black Mountain*, Buncombe county, North Carolina, U. S. A.
25.	"	1839,	*Asheville*, Buncombe county, North Carolina, U. S. A.
26.	"	1839,	*Putnam* county, Georgia, U. S. A.
27.	"	1840,	*Cocke* county (Cosby-Creek, also Sevier county), Tennessee, U. S. A.
28.	"	1841,	*Newberry* (Ruff's Mountain), South Carolina, U. S. A.
29.	"	1842,	*Green* county (Babb's Mills), Tennessee, U. S. A.
30.	"	1843,	*Oaxca*, Mexico.
31.	Discov.	1843,	*St. Augustine's Bag*, Madagascar.
32.	"	1843,	*Arva* (Szlanicza), Hungary.

33.	Discov.	1845,	*Otsego* county, New York, U. S. A.
34.	"	1845,	*De Kalb* county, Tennessee, U. S. A.
35.	"	1846,	*Carthage*, Tennessee, U. S. A.
36.	"	1847,	*Chesterville*, Chester District, South Carolina, U. S. A.
37.	Fell	1847, July 14,	*Braunau*, (Hauptmannsdorf), Koeniggraetz, Bohemia.
38.	Discov.	1847,	*Seeläsgen*, Newmark, Brandenburg, Prussia.
39.	"	1850,	*Schwetz*, Province of Prussia.
40.	"	1850,	*Salt River*, Kentucky, U. S. A.
41.	"	1850,	*Pittsburg*, Pennsylvania, U. S. A.
42.	"	1850,	*Seneca Falls*, Cayuga county, New York, U. S. A.
	Discovered.		
43.	1850–1854,		*Lion River*, Namaqua Land, South Africa.
44.	" "		*Union* county, Georgia, U. S. A.
45.	" "		*Tazewell*, Claiborne county, Tennesse, U. S. A.
46.	" "		*Santa Rosa*, New Mexico.
47.	" "		*Tuczon*, Sonora.
48.	" "		*Hemalga*, Talcahuaxo, Chili.
49.	" "		*Haywood* county, North Carolina, U. S. A.
50.	" "		*Oktibbeha* county, Mississippi.
51.	" "		*Orange River*, South Africa.
52.	1854,		*Madoc*, Canada West.
53.	1856,		*Hainholz*, S. W. of Paderborn, Minden, Westphalia.
54.	"		*Forsyth*, Taney county, Missouri, U. S. A.
55.	"		*Nebraska Territory*, (between Council Bluffs and Fort Union), on the Missouri River.
56.	"		*Campbell* county, Tennessee, U. S. A.
57.	"		*Nelson* county, Kentucky, U. S. A.
58.	"		*Jewell Hill*, Madison, co., North Carolina, U. S. A.
59.	"		*Marshall* county, Kentucky, U. S. A.
60.	"		*Brazos*, Texas, U. S. A.
61.	"		*Denton* county, Texas, U. S. A.
62.	"		*Oldham* county, near Lagrange, Kentucky, U. S. A.
63.	"		*Robertson* county, Tennessee, U. S. A.

Total—88 Stones and 63 Irons, or 151 Meteorites. Their aggregate weight is 820 pounds. The largest stone weighs 51 pounds, and the largest iron mass, 326. The collection contains a large problematical mass from Homony Creek, Buncombe county, North Carolina, supposed to be an altered meteoric iron; also numerous native iron and steel-like masses whose origin is not understood, but which are suspected to be meteoric. To this latter group belong the specimens from Achen, France; Collina de Brianza, Brazil; Walker county, Alabama; Scriba, New York; Randolph county, North Carolina; Bedford county, Pennsylvania; Montgomery, Vermont; Rutherford, North Carolina, and some others. The black capillary matter seen to fall in a glowing state at Charleston, South Carolina, on the evening of Nov. 16, 1857, is also preserved in this collection.

New Haven, Conn., Nov., 1860.

2. *Note and Correction to Mr. T. Sterry Hunt's paper on Types,* this vol. p. 256–264.—To follow the note on p. 261:—"The formation of a nitrite in the experiments of Cloez appears to be independent of the presence of ammonia, and to require only the elements of air and water (*Comptes Rendus*, lxi, 935). Some experiments now in progress lead me to conclude that the appearance of a nitrite in the various processes for ozone, is due to the power of nascent oxygen to destroy by oxydation the ammonia generated by the action of water on nitrogen, the nitrous nitryl; so that the odor and many of the reactions assigned to ozone or nascent oxygen are really due to the nitrous acid which is set free when nascent oxygen encounters nitrogen and moisture. On the other hand, nascent hydrogen, which readily reduces nitrates and nitrites to ammonia, by destroying the regenerated nitrite of the nitryl, produces ammonia in many cases from atmospheric nitrogen."

Two errors of the press occur in the first seven lines of p. 264—which are corrected in the following paragraph:

"Without counting the still more basic sulphates of zinc and copper, described by Kane and Schindler, we have the following salts, which in accordance with Wurtz's notation, correspond to the annexed radicals:

1. Unibasic, - - - -	$S_2H\,O_7 = S_2O_5$	monatomic.
2. Bibasic, - - - - -	$S_2H_2O_8 = S_2O_4$	diatomic.
3. Quadribasic, - - - -	$S_2H_4O_{10} = S_2O_2$	tetratomic.
4. Sexbasic, - - - -	$S_2H_6O_{12} = S_2$	hexatomic.
5. Octobasic, - - - -	$S_2H_8O_{14} = S_2 - O_2$	octatomic.

3. *Texas Survey.*—We have received the following note from W. M. Gabb on this subject, which we publish without comment.

"I take this opportunity of correcting a statement in your last issue of the Am. Jour. Sci. in regard to my friend Dr. Moore of the Texas Geological Survey. * * * Having been personally cognizant of all the circumstances connected with the change, I feel able to speak confidently of the matter.

"It was determined that when Dr. Shumard's term of appointment should expire (November, 1860) that he should be removed. There were two applicants for the post, and Dr. Moore obtained the use of certain 'influential names' for the purpose of counteracting the weight of a letter written by Humboldt some thirty years ago, in recommendation of the other applicant, and *not* to prejudice Dr. S., whose removal had *nothing* to do with the appointment of any particular successor.

"While I have every confidence in Dr. Shumard's ability as a geologist, I cannot believe that his successor is inferior to him either in erudition, skill or ability. I hope therefore that you will do justice to a gentleman who has been thus unfairly placed before the scientific public.

I remain your ob't serv't, W. M. Gabb."

Philadelphia, March 28, 1861.

4. *Kentucky Geological Reports.*—On page 294 we spoke of the fourth volume of the Kentucky Reports now in press as the 'concluding' volume. As the survey of Kentucky is far from being complete, it is to be hoped that new appropriations of money will enable Dr. Peter and his associates to go on with the work. The chemical part of the fourth volume, covering 390 pages and a vast amount of chemical labor, has just reached us, and will be noticed hereafter.

OBITUARY.

ERNEST HAEUSSER, an excellent geologist and mining engineer, died in New York on the 18th of February, aged about 35 years. A native of Saxony, educated by the government at the Mining Academy at Freiberg, he came to this country about eight years ago. He was engaged on the Geological Survey of New Jersey, chiefly in the examination of the northern counties of that State, from 1855 to the suspension of the survey. Some of the results of his labors (without his name) have appeared in the Annual Reports of that survey. Frequent exposure to the sickly climate of the Southern States when exploring in North Carolina and elsewhere, broke down his health, developing by intermittent fever the consumption which carried him off. Cautious, truthful, excellent in character, his decease is a great loss to mining enterprises, in which there is always need of the qualities which distinguished Ernest Haeusser.

Botanical Necrology for 1860.—*Professor Hochstetter* of Esslingen, Wirtemburg, died on the 19th of February, at the age of 74 years. The Rev. Prof. Hochstetter produced no important botanical works; but he and his associate Steudel, whom he survived two or three years, were active promoters of botany through the *Unio Itineraria*, an association for furthering botanical collections—of which they were the managers.

Professor J. G. C. Lehmann, of Hamburgh, who died on the 12th of February, in his 68th year, was a botanist of note, and a voluminous author. His earliest work, a monograph of *Primula*, appeared in 1817, his monograph of the *Asperifoliæ* the year after, that of *Potentilla* in 1820. He elaborated the *Onagraceæ* and his favorite genus *Potentilla* for Hooker's Flora of British America; and his latest publication of any magnitude and crowning work was his *Revisio Potentillarum*, a fine quarto volume with 64 plates, issued in the year 1856, an excellent monograph.

G. H. von Schubert, a Bavarian botanist of a former generation, to whom Mirbel in 1813, under the name of *Schubertia*, dedicated the genus established for our southern Cypress, which Richard had earlier called *Taxodium*—survived until July last, having attained the age of 80 years. He is commemorated in an Asclepiadeous genus from Brazil, established by his fellow-countrymen, Martius and Zuccarini.

Dr. J. F. Klotzsch, keeper of the Royal Herbarium at Berlin for the last twenty-five years, died on the 5th of November last at the age of 55 years. As a systematic botanist, Dr. Klotzsch worked industriously, observed discriminatingly, but generalized badly, or rather—like others of the same school—wanted that largeness of view which enables the able naturalist to discover, almost instinctively, the true characters and just subordination of natural groups, in the midst of the most diversified details, and that gift of sound judgment as to natural genera in which Linnæus and the other great masters so much excelled most even of the better botanists of the present age. Dr. Klotzsch's monograph of *Begoniaceæ*, and his papers on *Euphorbiæ* (one of the latter, which dismembers the Linnæan genus *Euphorbia* into more than a dozen genera, published during the past year,) are striking illustrations of the opposite system. The distinctions are doubtless for the most part true and good; their valuation is open to serious objection.

Louis de Vilmorin, of Paris, died on the 22d of March, 1860, at the age of 44 years. Although his name and that of his venerable, still-

surviving father (to whom DeCandolle dedicated the genus *Vilmorinia,*) hardly appears in the catalogue of botanical authors, yet both have rendered important service to botanical science, while contributing most essentially to the advancement of agriculture and horticulture by original observations, and by experimental researches, devised and conducted upon truly scientific principles, respecting the formation of varieties and their fixation into races, and the amelioration and augmentation of the useful products of cultivated plants. A notice of some of the brief but most suggestive papers of the Vilmorins upon this subject was given in the 27th volume (new series) of this Journal (May, 1829). In devising and conducting such experiments, often requiring both physiological and chemical knowledge, a delicate skill in manipulation, and a quick eye for natural affinities, the younger Vilmorin was unrivalled, and his death in the midst of so useful and so honorable a career, has left a serious void. It is but just to his memory to acknowledge that we have learned more from him respecting the laws and conditions which govern both the production and the preservation of vegetable varieties and races than from any other source. What with his characteristic modesty he entitled an *Essai d'un Catalogue Methodique et Synonymique des Froments*, arranging the sorts of Wheat known in cultivation under fifty-three sections, reduced to seven botanical species, is a work which required the researches of years, although only a pamphlet of fifty pages, and is his most extended publication. His several articles, since collected under the title of *Notice sur l'amélioration des plantes par le senis, et considérations sur l'heredité des vegetaux* are characteristically brief. But they are all the result of the most conscientious, skillful, and prolonged investigations, and all are real contributions to knowledge, the value of which is not to be estimated by the bulk of the record.

J. B. Payer, one of the botanical members of the Academy of Sciences, and Professor of Vegetable Organography and Anatomy of the Faculty of Sciences, at Paris, died on the 5th of September last, aged only 42 years. The correspondence of M. Nicklès has already supplied a biographical notice of Payer, in the preceding (March) number of this Journal. His speciality was organogeny; his principal work *Traité d'Organogénie Comparée de la Fleur*, in imperial octavo, with 154 crowded plates, is a very handsome and imposing production, but perhaps not of the highest critical value. His seat at the Academy of Sciences has recently been filled by another organogenist, of excellent promise, M. Duchartre.

John E. LeConte, former Major of U. S. Topographical Engineers,—whose death, at Philadelphia, in November last, aged 77, was announced in our March No., (p. 303)—was almost the Nestor of American botanists, although his principal contributions to science, except the earlier, relate to zoology, chiefly to entomology and herpetology. His first botanical publication, a Catalogue of the Plants growing spontaneously on the Island of New York, appeared just half a century ago. Many of the choicest botanical stations even seventeen years later, when Dr. Torrey issued his Catalogue of the same district, were as low as Canal St., and Peck's Slip. Even the earlier author lived to see nearly his whole florula extinguished, swept away by denudation, or unconformably overlaid by recent strata of stone, brick and mortar. Major LeConte made exten-

sive collections in Georgia at a period when that part of the country had been little explored, and freely imparted his materials and his valuable observations to working botanists. He also published several good botanical papers in the earlier volumes of the Annals of the Lyceum of Natural History, New York, and more recently, in the Proceedings of the Academy of Natural Sciences, Philadelphia, an Enumeration of the North American Vines, and a paper on the species of Tobacco, with which, unfortunately, we are not acquainted. For the last ten or twelve years Major LeConte has resided in Philadelphia; and we are to expect from one of his scientific associates there, a fitting tribute to the memory of this venerable, genial, and accomplished gentleman and naturalist.

A. G.

Death of Prof. J. W. Gibbs.—JOSIAH WILLARD GIBBS, LL.D., Professor of Sacred Literature in Yale College, died in New Haven, March 25, 1861, aged 70.

He was born in Salem, Mass., April 30, 1790, and graduated at Yale College in 1809. He was Tutor in this institution from 1811 to 1815, and Librarian from 1824 to 1843. From 1826 to the time of his death he was Professor of Sacred Literature in the Theological Department of the College, having been Lecturer here in 1824 and 1825. He was author of a valuable Hebrew Lexicon, and of an abridgment thereof, and of several minor works relating to grammatical and philological subjects, as well as of numerous contributions to the periodical works of his time. The earlier volumes of this Journal contain several important papers from his pen.

He was eminent for careful and thorough research, and all his productions bear marks of exact scholarship. He had been for several years an active member of the American Oriental Society, and of the Connecticut Academy of Arts and Sciences. The last named body, at their meeting of April 17, 1861, passed resolves expressive of their high estimate of the character of the deceased and lamenting his departure.

New Planets.—A new planet, of the 13th magnitude, was discovered April 9, 1861 by Mr. H. P. Tuttle, at the Observatory at Cambridge, Mass. It is probably the 66th of the asteroidal group, the 64th and 65th having been discovered at Marseilles, March 4 and 11, 1861.

New Comet.—A telescopic comet was discovered early in April, in *Draco*, by Mr. Thatcher, at the observatory of Mr. L. M. Rutherford in New York City.

NOTICE.—*The American Association for the Advancement of Science.*—The Standing Committee have announced that the meeting adjourned to Nashville for 17th April, 1861, will be postponed for one year, to be convened in Nashville, April 1862, unless otherwise ordered in the meantime.

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